The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

March 1942

Obstetrics . Gynecology

Vascular Surgery . Urology

Anesthesia . Gastrointestinal Surgery

Neurological Surgery . Orthopedics

The American Journal of Surgery, Inc.

49 WEST FORTY-FIFTH STREET · NEW YORK

EDITORIAL BOARD

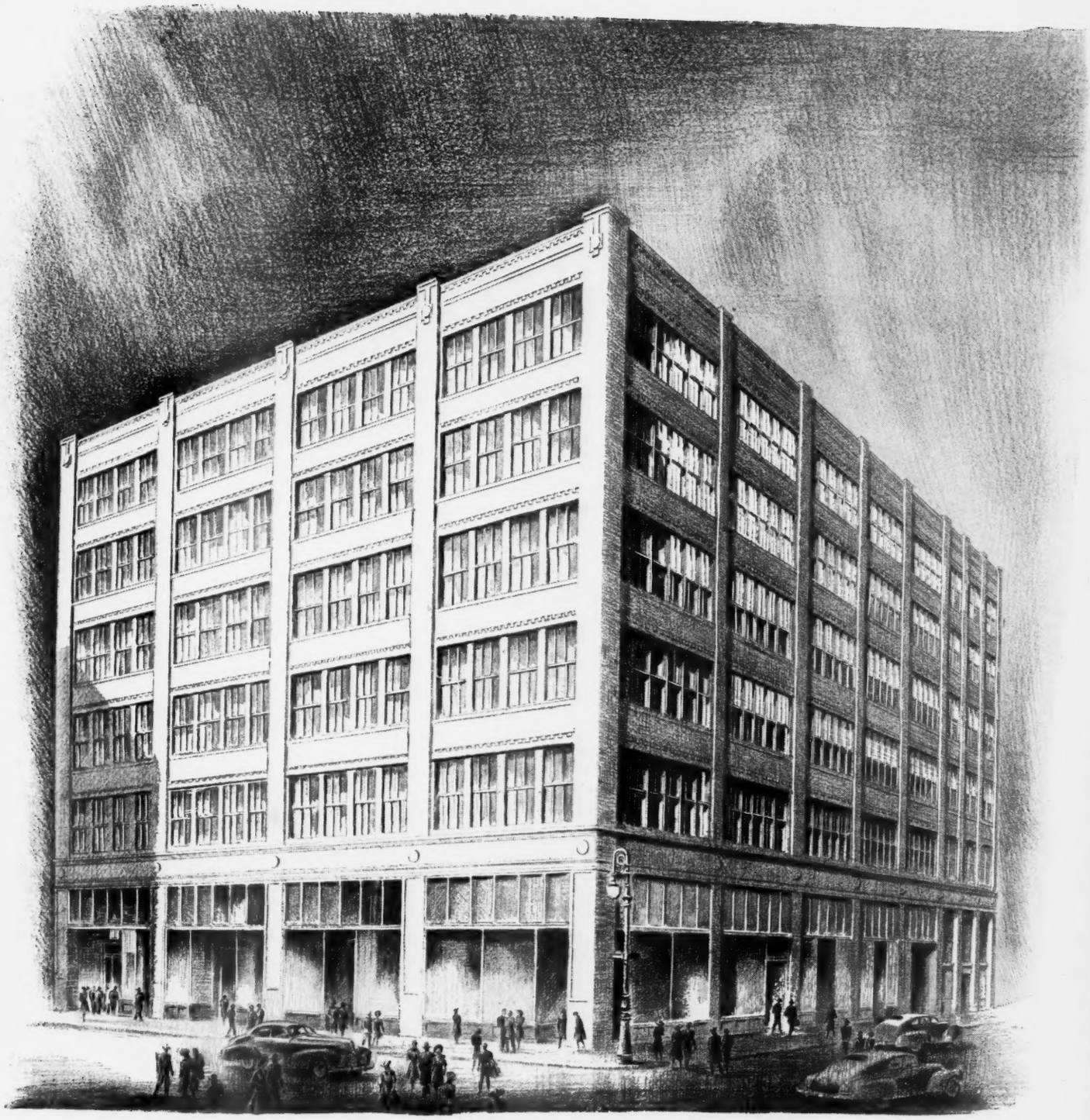
The American Journal of Surgery

Editor THURSTON SCOTT WELTON, *New York*

ASSOCIATE EDITORS

FRED H. ALBEE, *New York*
CARL BECK, *Chicago*
CLAUDE S. BECK, *Cleveland*
GEORGE R. BRIGHTON, *New York*
MEREDITH F. CAMPBELL, *New York*
JAMES T. CASE, *Chicago*
ISIDORE COHN, *New Orleans*
BRADLEY L. COLEY, *New York*
FREDERICK A. COLLER, *Ann Arbor*
PAUL C. COLONNA, *Oklahoma City*
GEORGE W. CRILE, *Cleveland*
ELLIOTT C. CUTLER, *Boston*
CHARLES A. ELSBERG, *New York*
HERBERT C. FETT, *Brooklyn*
C. R. G. FORRESTER, *Chicago*
JOHN H. GIBBON, *Philadelphia*
EMIL GOETSCH, *Brooklyn*
CHARLES A. GORDON, *Brooklyn*
DONALD GUTHRIE, *Sayre, Pa.*
ARTHUR E. HERTZLER, *Kansas City*
LOUIS J. HIRSCHMAN, *Detroit*
JAMES M. HITZROT, *New York*
FREDERICK C. HOLDEN, *New York*
EMILE F. HOLMAN, *San Francisco*
JOSEPH A. HYAMS, *New York*
JOHN E. JENNINGS, *Brooklyn*
Washington, WILLIAM L. KELLER
Baltimore, HOWARD A. KELLY
New York, THOMAS J. KIRWIN
New York, ARTHUR KRIDA
New York, ADRIAN V. S. LAMBERT
New York, MAURICE LENZ
New York, H. H. M. LYLE
New York, JEROME M. LYNCH
New Orleans, URBAN MAES
Newark, HARRISON S. MARTLAND
New Orleans, RUDOLPH MATAS
Detroit, ROY D. MCCLURE
San Francisco, H. C. NAFFZIGER
Baltimore, EMIL NOVAK
Newark, CLARENCE R. O'CROWLEY
Boston, LOUIS E. PHANEUF
New York, EUGENE H. POOL
Rochester, Minn., JAMES T. PRIESTLEY
New York, DOUGLAS QUICK
Brooklyn, NATHANIEL P. RATHBUN
Raleigh, HUBERT A. ROYSTER
Philadelphia, HENRY S. RUTH
St. Louis, M. G. SEELIG
New York, J. BENTLEY SQUIER
New York, H. J. STANDER
Baltimore, GRANT E. WARD
J. HOMER WOOLSEY, *San Francisco*

The American Journal of Surgery is published monthly by the American Journal of Surgery, Inc., 49 West 45th Street, New York, N. Y. Yearly Subscription, $10.00 U. S. A.; $15.00 Canada; $12.00 Foreign. Single Numbers $2.00; Special Numbers $4.00. Entered as second class matter August 28, 1926, at the Post Office, New York, N. Y., under the act of March 3, 1879. March, 1942—New Series, Volume LV, No. 3.

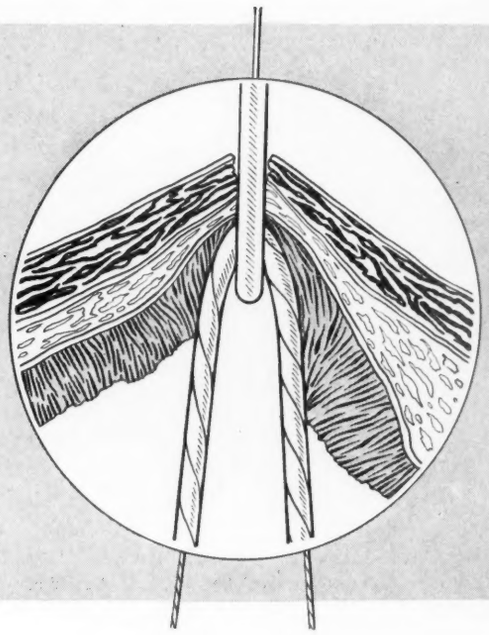


Davis & Geck Building, 57 Willoughby Street, Brooklyn

Davis & Geck has led the world in the production of sutures for over a quarter of a century. Schedules already far exceeding those of any other manufacturer have now been more than doubled through completion of our new Willoughby Street plant. With these added facilities and our long experience in large scale operation, we are prepared to meet any demands that may conceivably be made upon us.

D&G *Sutures with*

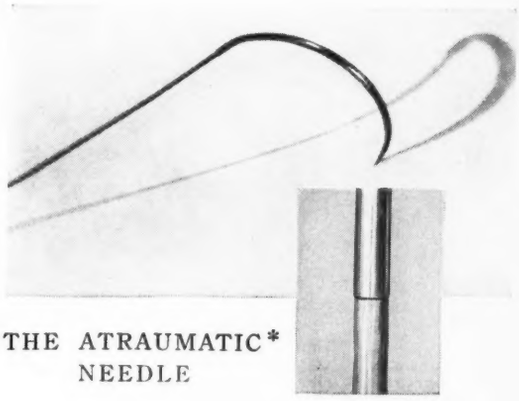
EYED NEEDLE — A doubled strand of suture must be drawn through the opening made by the needle—hence causing undue tissue injury



To MEET varied situations where minimized suture trauma is desirable, over one hundred D&G Atraumatic suture-and-needle combinations are now available. These range from delicate nerve sutures of size 8-0 silk to sturdy obstetrical sutures of size three catgut and include extremely fine strands armed with needles at both ends for convenience in certain procedures.

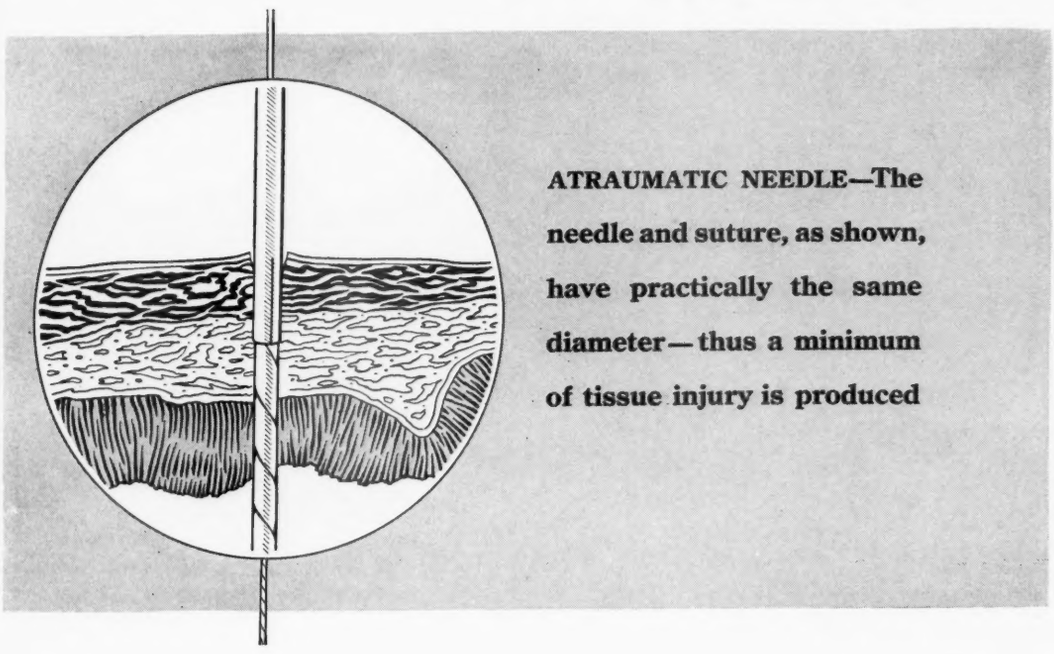
The practicability and convenience of these products has been demonstrated by a constant increase in usage. Davis & Geck, therefore, has extended the Atraumatic principle to a wide variety of products for use in general surgery as well as in the specialties.

The needles are of high quality steel, tempered against brittleness and resultant "snapping". Patented construction provides a sleeve of exceptional strength which will not bend or break; the method of affixing insures positive anchorage to the suture material—it cannot pull out. All curved needles have a flattened



THE ATRAUMATIC* NEEDLE

Atraumatic Needles



ATRAUMATIC NEEDLE—The needle and suture, as shown, have practically the same diameter—thus a minimum of tissue injury is produced

area to prevent turning in the needle holder.

Each special purpose suture has been developed in collaboration with recognized authorities and represents the consensus of professional opinion in its particular field.

In addition to the long list of Atraumatic suture-and-needle combinations specially designed for specific procedures, the D&G line presents a comprehensive range of non-needled sutures. These include catgut, kangaroo tendons and bands, ribbon gut, Anacap silk, Kal-dermic and Dermalon skin and tension sutures, and the various other non-absorbable materials.

D&G *Sutures with Atraumatic Needles*

INTESTINAL THYROID TONSIL EYE HARELIP

CLEFT PALATE PLASTIC NERVE ARTERY OBSTETRICAL

CIRCUMCISION URETERAL RENAL

Description and prices on request

* D&G Registered Trade Mark

SUTURES IN ANCIENT SURGERY

WALTER HERMAN RYFF in his *Great Surgery*, published in 1546, describes a number of mechanical methods for closing wounds. Among them was the device of applying strips of plaster to the wound edges and sewing through the fabric instead of the tissues. Another described as a small clasp with a barb at each end is perhaps a forerunner of the skin clip. Ryff came from Strassburg originally, but spent his last twenty years in Mainz and Nurnberg. He was a prolific writer credited with the authorship of 48 books.

D&G Sutures

"THIS ONE THING WE DO"

DAVIS & GECK INC.

Respiratory Stimulant

LOBELIN - Bischoff

ACTS AS A DIRECT STIMULANT TO THE RESPIRATORY CENTER IN CASES OF NEONATAL ASPHYXIA

★

ERNST BISCHOFF COMPANY, Inc.
IVORYTON, CONNECTICUT

The American Journal of Surgery, Inc.

Reg. U. S. Pat. Off., Nov. 3, 1936

NEW SERIES VOL. LV — NUMBER THREE

Contents · March, 1942

Editorial

Principle of Natural Selection Applied to the Genesis of Cancer . . . . . *George Crile* 441

Original Articles

Reduced Temperatures in Surgery. III. Experiments on Pelvic and Abdominal Refrigeration with Especial Reference to Traumatic and Military Surgery *Frederick M. Allen* 451

Clinical and Anatomical Investigations of Deep Fascial Space Infections of the Hand . . . . . *J. Edward Flynn* 467

Ultraviolet Irradiation of Autotransfused Blood in the Treatment of Postabortional Sepsis . . . . . *E. W. Rebbeck* 476

Mortality of Cholecystectomy in the Male . . . . . *Carl A. Bachhuber* 487

Abdominal Neuralgia in Relation to the Superficial Abdominal Nerves . . . . *John L. Ingham* 492

Contents Continued on Page 3

Don't Worry Too Much About This Shortage

FORTUNATELY, there need not be much concern over the shortage of Belladonna. Syntropan the 'Roche' synthetic, non-narcotic antispasmodic is being produced in adequate quantities and is available to the entire medical profession. Many physicians consider the action of Syntropan 'Roche' superior to that of Atropine or Belladonna, and, of much importance, the use of Syntropan affords greater *safety*—less likelihood of mouth dryness, mydriasis, or tachycardia. In other words, in relation to its activity Syntropan is less toxic than Belladonna and its derivatives.

Try Syntropan in the place of Atropine or Belladonna, to effectively control smooth-muscle spasm—*in spastic disorders of the cardiovascular system* such as arterial spasms, angina pectoris, and effort syndrome; *in gastro-intestinal disorders* for the relief of spasms due to hyperacidity and peptic ulcer, and pylorospasm; *and in urogenital disorders* for the relief of spastic states of the bladder and ureter musculature. One 50-mg. Syntropan tablet in the place of 1/120 gr. (0.5 mg.) of Atropine Sulfate is recommended. Packages: Oral tablets (50 mg. each) in tubes of 20 and bottles of 100; 1cc ampuls (10 mg. each) in boxes of 6.

HOFFMANN-LA ROCHE, INC.
ROCHE PARK • NUTLEY • NEW JERSEY

Hoffmann-La Roche, Inc., Nutley, N. J.
Gentlemen: I should like to receive a professional sample of Syntropan, the 'Roche' synthetic, non-narcotic antispasmodic.

Dr._____

_____

_____

ajs 342

Try
SYNTROPAN
'ROCHE'
The Better Antispasmodic

The American Journal of Surgery

NEW SERIES VOL. LV

Contents • March, 1942

NUMBER THREE

Acute Appendicitis in Children . . . . . *Philip D. Allen* 495
Gastric Resection for Ulcer. Experience in Forty-four Cases . . . . . *C. Fremont Vale* 500
Continuous Spinal Anesthesia. Report of One Hundred Cases in Which This Method Was Employed . . . . . *F. Paul Ansbro and L. J. Pico* 504
Suprapubic Trocar Drainage of the Bladder . . . . . *George Austen, Jr.* 509
Proctology in General Office Practice . . . . . *Robert Turell* 516
Peripheral Vascular Surgery. Lessons from Six Years' Experience *F. M. Al Akl, Alexander Singer and C. Burling Roesch* 520
Cephalic Bruit. A Review of the Literature and a Report of Six Cases . . *Maxwell J. Mackby* 527
Prolonged Stupor Produced by Subdural Hygroma. Relief by Trephine and Drainage . . . . . *Michael Scott* 534
Method of Suspending the Uterus without Open Abdominal Incision. Use of the Peritoneoscope and a Special Needle *J. K. Donaldson, Joe H. Sanderlin and Wm. B. Harrell, Jr.* 537
Diagnosis of Uterine Rupture . . . . . *A. Sadowsky* 544
Partial Giant Growth. Operative Reduction in Size of a Foot . . . . . *Ernst Bergmann* 548
Use of the Transfibular Approach in Arthrodesis of the Ankle Joint . . . . *Thomas Horwitz* 550
Pathogenesis of Arthritis Following the Intravenous Injection of Staphylococci in the Adult Rabbit . . . . . *R. H. Rigdon* 553
Postoperative Infection. Its Control by Surgical Technic . . . . . *Joseph L. De Courcy* 562

Case Reports

Persistent External Intestinal Fistula. Review of the Literature with Report of an Unusual Case Following Appendectomy . . . . . *Max Michael Simon* 566
Compression of the Spinal Cord in Paget's Disease of the Vertebrae . . . . *Sidney W. Gross* 575
Pneumococcic Peritonitis . . . . . *Maurice Culmer O'Shea* 578
Cranial Chordoma. Report of a Case in Which Surgical Intervention Was Successful . . . . . *F. A. Carmichael, Jr., F. C. Helwig and J. H. Wheeler* 583
Postoperative Gangrene of the Finger Following Digital Nerve Block Anesthesia. Report of a Case . . . . . *Charles W. McLaughlin, Jr.* 588
Unusual Metastasis of Rectal Carcinoma. Case Report . . . . . *Irving Greenfield* 590
Spontaneous Hemorrhage into the Rectus Abdominis Muscle Simulating Acute Intra-abdominal Conditions . . . . . *George Strenger* 594
Implant Skin Grafting. Case Report . . . . . *William S. S. Horton* 597
Migrating Foreign Body . . . . . *Frank Foncannon* 600
Massive Fatal Rectal Hemorrhage from Capillary Oozing. Case Report . . *D. A. MacGregor* 602
Removal of Intrapleural Foreign Body under Thoracoscopic Guidance. Case Report . . . . . *George Willauer and Richard J. Chodoff* 606
Allergic Reaction Following Blood Transfusion. Apparent Desensitization of Recipient . . . . . *Robert E. S. Young* 607
Lymphosarcoma of the Intestinal Tract. Report of a Case in Which There Was an Apparent Five-year Cure . . . . . *Henry H. Ritter and James M. Shaffer* 611

Bookshelf Browsing

Evolution of Blood Transfusion . . . . . *Leo M. Zimmerman* 613
Author Index to Volume LV 622
Subject Index to Volume LV 622

General Information on Page 4 *Advertising Index on 3rd cover*

General Information

THE AMERICAN JOURNAL OF SURGERY does not hold itself responsible for any statements made or opinions expressed by any contributor in any article published in its columns.

Articles are accepted for publication with the understanding that they are original contributions never previously published. All manuscripts are subject to editorial modification, and upon acceptance become the property of THE AMERICAN JOURNAL OF SURGERY, INC.

A reasonable number of illustrations are supplied free of cost; special arrangements must be made with the editor and publishers for excess illustrations and elaborate tables.

Reprints are furnished on order. Prices are quoted when articles are in page form.

Material published in THE AMERICAN JOURNAL OF SURGERY is copyrighted and may not be reproduced without permission of the publishers.

Change of address must reach us by the 15th of the month preceding month of issue.

PREPARATION OF MANUSCRIPTS

Text. Manuscripts are to be typewritten, on one side of the paper, with double spacing and good margins. The original should be sent to the editor and a carbon copy retained by the author.

Illustrations. Illustrations must be in the form of glossy prints or drawings in black ink (*never* in blue). On the back of each illustration the figure number, author's name and an indication of the top of the picture should be given. Legends for illustrations are to be typewritten in a single list, with numbers corresponding to those on the photographs and drawings. Please do not attach legends to the pictures themselves.

Bibliographies. Bibliographic references should be at the end of the manuscript, in alphabetical order, and not in footnotes. Each reference should include the following information in the order indicated: Name of author with initials; title of article; name of periodical; volume, page and year. The following may be used as a model:

PHANEUF, LOUIS E. Indications and technique. *Am. J. Surg.*, **25**: 446, 1937.

The author should always place his full address on his manuscript.

The subscription price of THE AMERICAN JOURNAL OF SURGERY, is $10.00 per year in advance in the United States; $15.00 in Canada; and $12.00 in foreign countries. Current single numbers $2.00. ALL SPECIAL NUMBERS $4.00. Prices for such back numbers as are available will be quoted on request.

Address all correspondence to

The American Journal of Surgery, Inc.

49 WEST 45TH STREET · NEW YORK

"UNSEEN CONSULTANTS" HELP MEET WAR CRISIS IN MATERNAL CARE

Crabtree's "Urological Diseases of Pregnancy" — First Book of its Kind Since 1841 — Sums Up a Century of Decisive Achievement

With the publication of "Urological Diseases of Pregnancy" by E. Granville Crabtree, M.D., a vast fund of knowledge, hitherto hidden in the world literature on this subject, is now made available to all clinicians, particularly obstetricians and urologists.

Even more important are the decisive advances in endocrinology and physiology, with special reference to the pregnant state, which have taken place during the last decade, and which are now included in Dr. Crabtree's new book.

Today, good books on aspects of maternal care are doubly needed, as 50,000 doctors are called to the Armed Services.

More than twenty years of practice and investigation in the field of urology have particularly fitted the author to present and interpret the literature of the last hundred years on the urology of pregnancy. An exhaustive bibliography—the first of its kind ever published—provides easy access to the extensive sources.

More than Pyelonephritis — A Complete Diagnostic, Clinical and Surgical Guide to Diseases of Urinary Tract in Pregnancy

You will undoubtedly wish to examine the Table of Contents of this thoroughly practical, much-needed reference-guide. Endocrinological and physiological changes in pregnancy, anomalous conditions and preexisting pathology, etiology, infections, complications, treatment, corrective surgery—here is an up-to-date handbook on *all* urinary diseases in relation to pregnancy and how to deal with them in your daily practice. Use the coupon below — examine the book at leisure — it will prove an ever-helpful "unseen consultant", now and for years to come!

"Urological Diseases of Pregnancy" by E. Granville Crabtree, M.D., Urologist to the Boston Lying-In Hospital, with a chapter on "The Toxemia of Pregnancy" by Dr. George C. Prather. 168 Illustrations, 6 in color. $6.50.

LITTLE, BROWN & CO.
Medical Book Department

LITTLE, BROWN & COMPANY
34 Beacon Street, Boston, Mass.

Please send me the book marked (A) above.

☐ **Check enclosed.**

☐ **Charge my account.**

Name .....

Address .....

City .....

State .....

Quoted

FROM ONE OF MORE THAN 300 PUBLISHED PAPERS

"The mortality in patients with appendicitis has been reduced since using pentothal sodium anesthesia. In my opinion the advantage has been in the complete relaxation—there is no straining or periods of resistance or the slightest excursion of the intestines into the field of operation."

Carraway, C. N., M. D., F. A. C. S.

Pentothal Sodium Oxygen Anesthesia in Major Surgery
South. Surgeon, Vol. IX, No. 5, pp. 312-320, May, 1940.

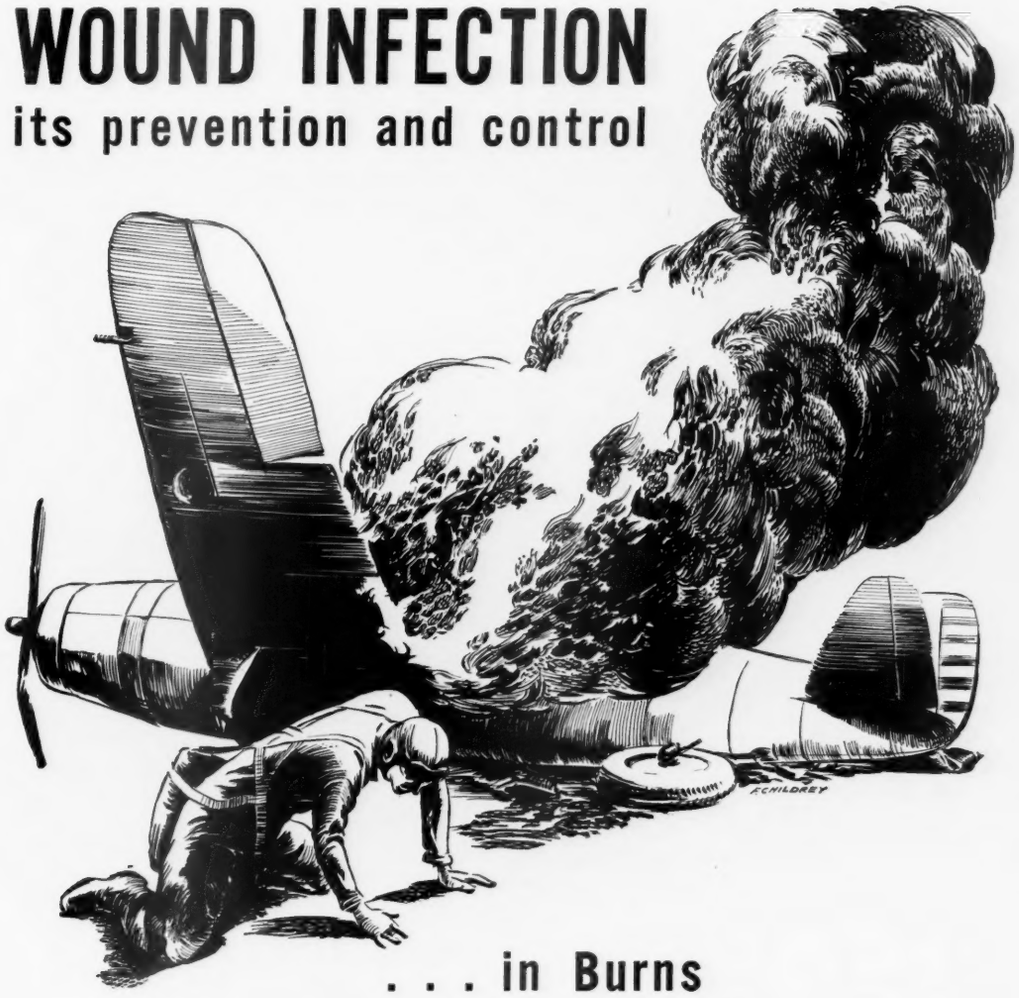
FOR INTRAVENOUS ANESTHESIA

Pentothal
REG. U. S. PAT. OFF.
Sodium

(Sodium Ethyl [1-Methyl-Butyl] Thiobarbiturate, Abbott)

Descriptive literature will be sent upon request. Address inquiries to
ABBOTT LABORATORIES
North Chicago, Illinois

WOUND INFECTION
its prevention and control



. . . in Burns

Widespread recognition that a burn is a wound and must be treated as such requires that adequate prophylactic treatment be given to prevent infection.

Regardless of the technic favored for the burn under treatment Azochloramid will aid in the prevention of infection or control of frank infection.

Commenting on the successful application of Azochloramid in his paper "Burns in Children" (J. A. M. A. Vol. 112, pp. 2235-2240) the author says, "We have found Azochloramid to be of considerable value in treating large infected granulating areas. Only one dressing is required daily . . ."

Many other reports attest to the unusual value of Azochloramid in the preparation of burned areas for skin grafts.

ACCEPTED AMERICAN MEDICAL ASSN. Council on Pharmacy and Chemistry

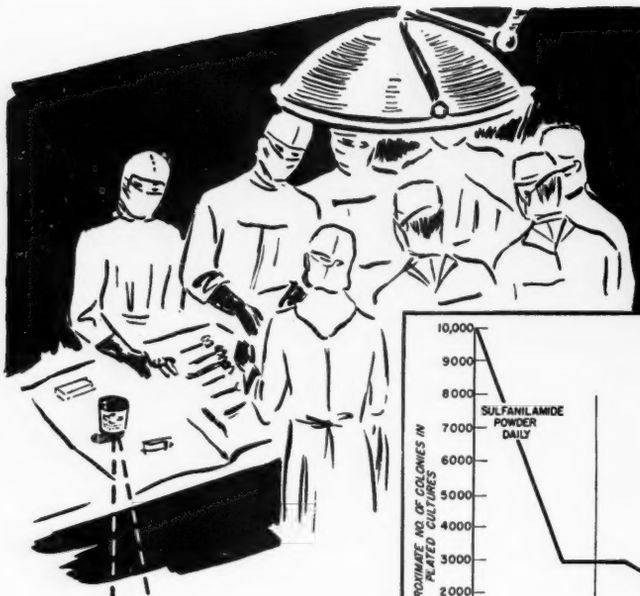
Azochloramid N-N'-DICHLOROAZODICARBONAMIDINE MEETS THE CHALLENGE OF INFECTION

•

Azochloramid is in extensive use by the Army and Navy

Trial quantities and comprehensive literature sent to physicians on request

WALLACE & TIERNAN PRODUCTS, INC.
Belleville, New Jersey, U.S.A.



In SURGICAL *and other* INFECTIONS

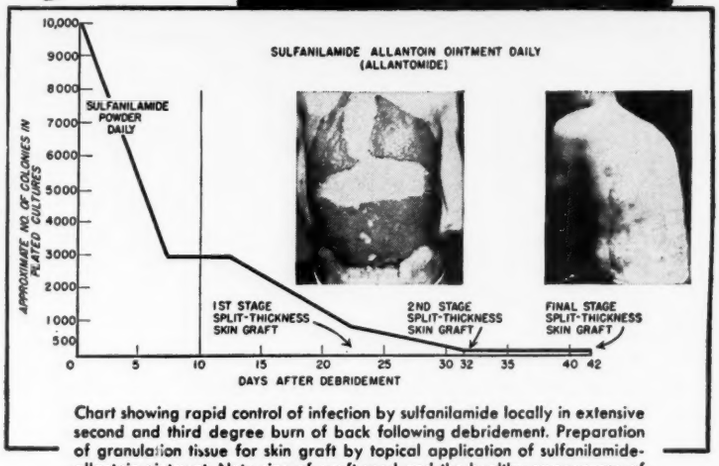


Chart showing rapid control of infection by sulfanilamide locally in extensive second and third degree burn of back following debridement. Preparation of granulation tissue for skin graft by topical application of sulfanilamide-allantoin ointment. Note size of graft used and the healthy appearance of granulation tissue. Case illustration courtesy American Journal of Surgery.

ALLANTOMIDE is valuable in preventing and combating infection in clean or grossly contaminated wounds; compound fractures, infected burns, varicose ulcers, decubitus ulcers, infected traumatic wounds, localized abcesses, carbuncles and preparing granulating surfaces for skin grafting.

After the infection is under control following adequate debridement of the wound and the application of sulfanilamide powder, Allantomide is applied daily, topically, on fresh dressings covering the entire affected area. This stimulates growth and granulation tissue.

ALLANTOMIDE

(U. S. Patent No. 2,121,295)

Allantoin 2% with Sulfanilamide 10% in a Greaseless Base

"The substitution of sulfanilamide-allantoin ointment for the pure powder allows a prompt resumption of the normal healing process and at the same time maintains a clean wound."*

"The excellent results obtained by preparing some forty superficial wounds for skin grafting by the local use of sulfanilamide and sulfanilamide-allantoin ointment (Allantomide) has been most encouraging. The method is simple and applicable to all areas of the body."**

*Veal, J.R., and Klepser, R.G. (Surgery Dec. 1941)

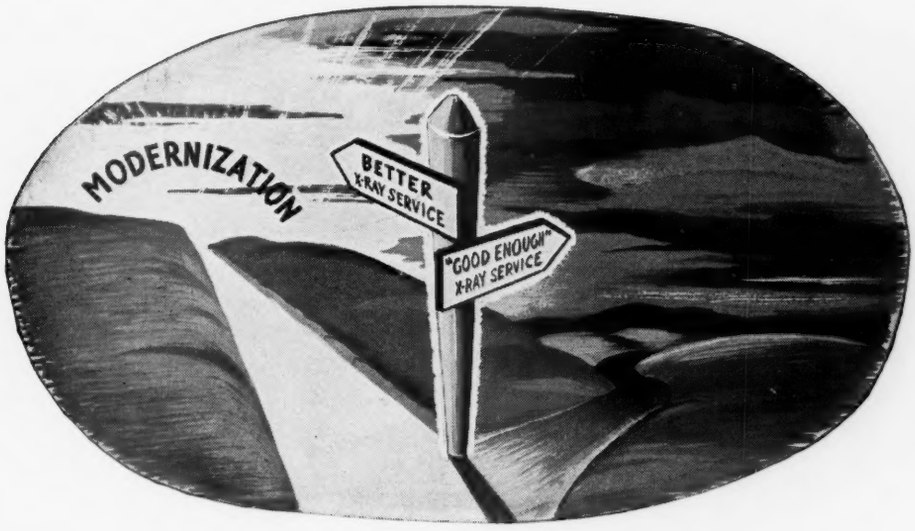
**Veal, J.R.; Klepser, R.G. and DeVito, Michael P. (American Journal of Surgery Dec. 1941)

ALLANTOMIDE *is supplied in one ounce tubes and also in four ounce, one and five pound jars.*

For Literature Write to The National Drug Company, 4663 Stenton Ave., Philadelphia, Pa.

NATIONAL DRUG CO.

There's a Definite Trend•••



Toward Better Hospital X-Ray Service

● Verily, more and more hospitals, everywhere, are modernizing their x-ray facilities, to afford patients the benefits of the better, more efficient service which notable developments in equipment have made possible.

With the continuous advancement of medical science, the ultimate obsolescence of equipment is inevitable. One can perhaps "make it do" for a while—procrastinate its relegation—provided an otherwise better service which patients must unwittingly forego does not eventually reflect unfavorably on the hospital's prestige.

"Does the service of our x-ray department measure up to present day standards?" is an oft propounded question which leads hospitals to this realization: that radiographs are now being produced the diagnostic value of which is unattainable with the finest x-ray apparatus of a relatively few years ago.

Likewise, the remarkable advances in the science of high-voltage x-ray therapy are a constant challenge to hospitals admitting patients for tumor therapy—that they adequately provide for such treatment with modern equipment specifically designed to meet the exacting requirements of the approved newer technics.

To hospital administrators and staff members who desire a fresh perspective of their institution's present x-ray facilities, in light of prevailing standards in modern hospital practice, we submit this suggestion: That you arrange to have one of our field technical experts call at your convenience, to give you the benefit of his knowledge and experience in a survey of this kind. You can rely on him to intelligently interpret your requirements, to offer you practical, helpful suggestions for the most satisfactory and economical solution of your particular problems. His recommendations, you may rest assured, will be based strictly on your actual and immediate needs.

A corps of expert layout engineers will collaborate in such a survey, by way of drawing up detailed floor plans with complete specifications to supplement the suggestions and recommendations as submitted.

Your inquiry will have most careful attention. Address Dept. E23.

GENERAL ELECTRIC X-RAY CORPORATION

2012 JACKSON BLVD. CHICAGO, ILL., U. S. A.

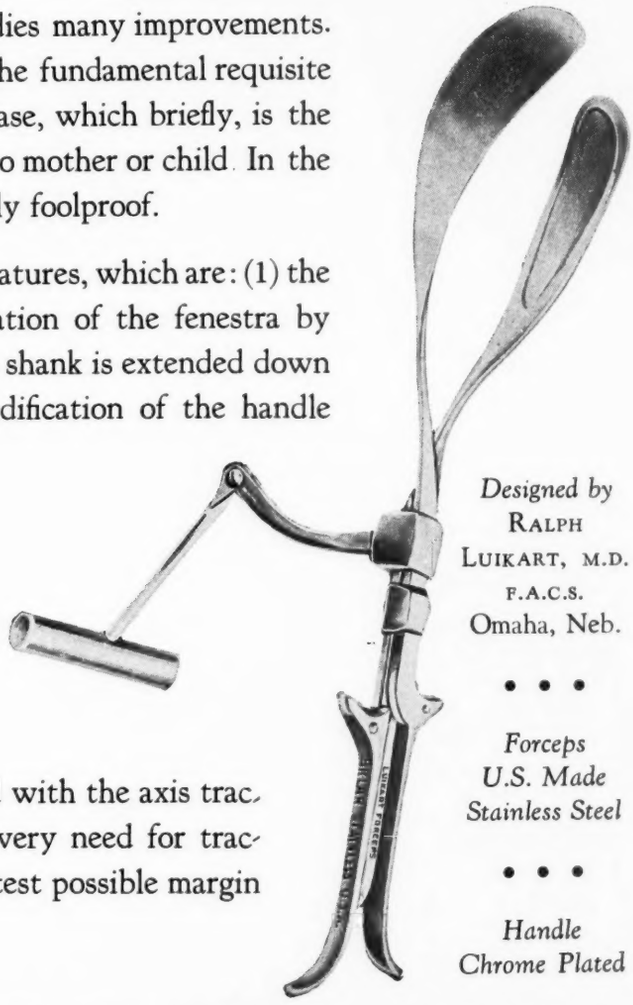
Luikart Obstetrical Forceps

A New Forceps Possessing a Sliding Lock, Modern Fenestra with Improved Handle, and Axis Traction Attachment

This newly designed forceps embodies many improvements. It is simple in design and meets the fundamental requisite for the safe and sane handling of each case, which briefly, is the extraction of the fetus with no damage to mother or child. In the hands of expert or novice it is practically foolproof.

This forceps embraces three safety features, which are: (1) the Kjelland type sliding lock, (2) modification of the fenestra by closing it on the pelvic side, and (3) one shank is extended down and is a part of one handle. This modification of the handle reduces the danger of excessive pressure of the blades on the fetal head. Kjelland type forceps are definitely improved by incorporating this safer handle. The blades have a conventional pelvic curve and well shaped cephalic curve.

The new Luikart Forceps, combined with the axis traction attachment, satisfactorily fulfills every need for traction, at the same time assuring the greatest possible margin of safety.



Designed by
RALPH
LUIKART, M.D.
F.A.C.S.
Omaha, Neb.

• • •

Forceps
U.S. Made
Stainless Steel

• • •

Handle
Chrome Plated

Reprint of article by Dr. Ralph Luikart in December 1940 American Journal of Obstetrics & Gynecology describing advantages and uses of this forceps will be sent on request.

Sold Only Through Surgical Supply Dealers

J. SKLAR MANUFACTURING COMPANY
38-04 WOODSIDE AVE. LONG ISLAND CITY, N. Y.
50th Anniversary

FURMERANE

(2-HYDROXY-MERCURI FURAN)

Germicide for General Use

Selective in action, Furmerane has the ability to destroy a remarkably wide variety of pathogenic bacteria, yet it is unusually free from tissue irritation in effective concentrations.

Because of its high degree of selectivity and its effectiveness in the presence of serum and exudates, Furmerane has a limitless field of usefulness, including—

Preoperative antisepsis **Obstetrical preparation**
Mucous membrane applications (E.N.T., vaginal, bladder)
Wound cleansing **Instrument sterilization**
Skin infections

Furmerane Solution.....1:3000—4-oz., pints and gallons
Furmerane Tincture.....1:400 —4-oz., pints and gallons
Furmerane Ointment.....1:3000—¾-oz. tubes and 1-lb. jars
Furmerane Nasal Drops with Ephedrine.....1-oz., 4-oz., pints and gallons

G·D·SEARLE & CO.

Ethical Pharmaceuticals Since 1888

CHICAGO New York Kansas City San Francisco

SEARLE

For Effective Control of

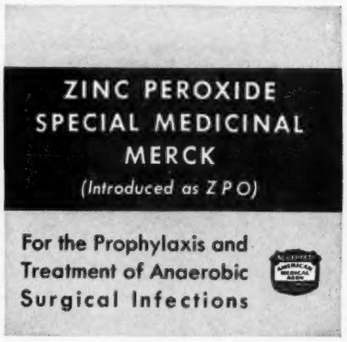
ANAEROBIC BACTERIAL WOUND INFECTIONS

ZINC PEROXIDE — SPECIAL MEDICINAL — MERCK (introduced as ZPO), conforms to the exacting chemical and physical standards required for the successful treatment of micro-aerophilic and anaerobic surgical infections. The following indications show its wide range of usefulness and the conditions in which effective clinical results have been observed when used in conjunction with appropriate surgical procedures:

- ***Chronic, Undermining, Burrowing Ulcers***
- ***As an adjunct following Thoracotomy***
- ***Anaerobic Infections of Dental Origin in the Face or Neck***
- ***Human Bites***
- ***Gunshot Wounds***
- ***Prophylaxis of Contaminated or Infected Accidental or Operative Wounds***

Zinc Peroxide—Special Medicinal—Merck is supplied in 1 oz. bottles—¼ lb. bottles—1 lb. bottles

Literature on Request



Buy Defense Savings Bonds and Stamps

MERCK & CO. Inc. *Manufacturing Chemists* RAHWAY, N. J.

the first line of defense . . .

HERE'S HOW you as a hospital can "do your bit" to aid "all out" American defense. You will assist production of defense materials also — as well as save money for your hospital. Make it your policy to REPAIR, RECONDITION, and RE-SHARPEN every surgical instrument which can be repaired, reconditioned, and re-sharpened.

If this has not been your policy may we venture the suggestion that you may be surprised how "almost like new" Weck-repaired; Weck-reconditioned, Weck-re-sharpened instruments are. And just to PROVE this — in line with the Weck policy of "REPAIRS AS USUAL"— despite the temptation to put all our experienced craftsmen on new instrument production we have not disturbed our repair personnel. Weck *guarantees* that you and your surgeons will be 100% satisfied with all the instruments you send us for repairing, reconditioning, and resharpening, or the bill will be 100% cancelled.

Could we make a fairer offer to prove the wisdom of a policy of REPAIRS AS USUAL — for the first line of defense? Why not send us a lot today? Return shipment will be made within one week of receipt by us.

Founded 1890.

Edward Weck & Co., Inc.
Manufacturers Surgical Instruments
SURGICAL INSTRUMENT REPAIRING • HOSPITAL SUPPLIES
135 Johnson Street Brooklyn, N.Y.

Pneumonia deaths will continue to decrease steadily with this most promising Sulfonamide . . .

SULFADIAZINE

Lederle

THE VALUE OF SULFAPYRIDINE AND SULFATHIAZOLE in the treatment of pneumococcal pneumonias has been impressively demonstrated by extensive clinical use. Sulfadiazine, the newest of the famous sulfonamide family, shows even greater promise. The ideal sulfonamide would be flexible in its method of administration, non-toxic to the host, devoid of sensitivity effects and would be therapeutically active against a wide range of common infecting agents. Although a perfect sulfonamide is unlikely of attainment, it is believed that sulfadiazine possesses distinct advantages in the treatment of certain conditions. CECIL[1] has expressed the opinion that clinically sulfadiazine is the best of the antipneumococcal drugs.

Recently clinical workers[2] have confirmed the results of earlier investigators[3] that sulfadiazine is equal in therapeutic efficiency to sulfapyridine or sulfathiazole in the treatment of pneumococcal pneumonia; is rapidly absorbed from the gastro-intestinal tract; the blood levels obtained are usually higher than with comparable doses of sulfapyridine and sulfathiazole; and excretion takes place slowly. All these factors coupled with the *infrequency of nausea and vomiting* tend to reassure both patient and physician.

Experimentally[4] sulfadiazine has been shown to compare favorably with sulfanilamide in its action against streptococci. The excellent therapeutic activity of the drug against experimental[5] hemolytic streptococcal and Friedlander's bacillus Type B infections has encouraged the clinical trial of sulfadiazine in these infections.

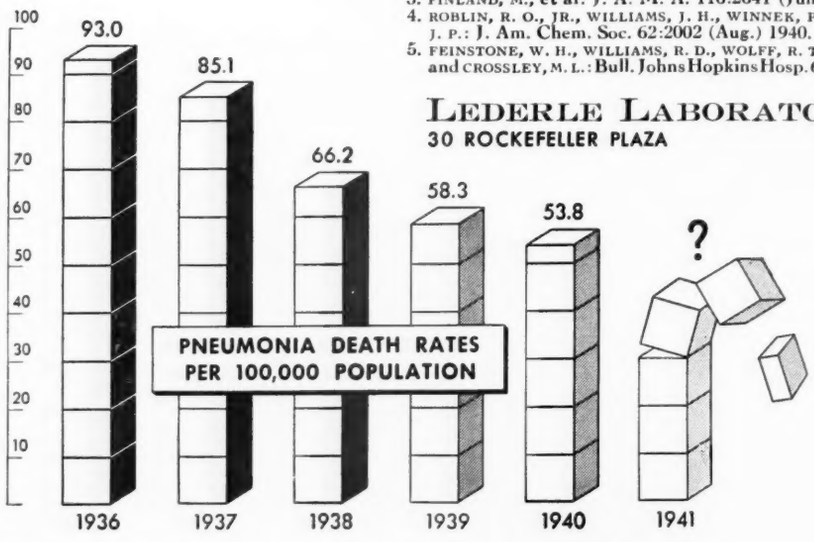
PACKAGES:
50 tablets, 7.7 grains (0.5 gram)
100 tablets, 7.7 grains (0.5 gram)
1000 tablets, 7.7 grains (0.5 gram)
5 grams powder (for standard solution only)

ACCEPTED AMERICAN MEDICAL ASSN.

Sodium Sulfadiazine *Lederle* (Powder)
1-5 gram bottle
6-5 gram bottles

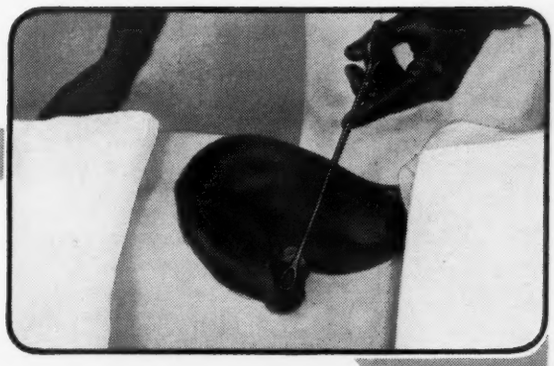
BIBLIOGRAPHY:
1. CECIL, R. L.: The Aesculapian, Chicago, 31:3 (March) 1941.
2. DOWLING, H. F., et al: J. A. M. A. 117:824 (Sept. 6) 1941.
3. FINLAND, M., et al: J. A. M. A. 116:2641 (June 14) 1941.
4. ROBLIN, R. O., JR., WILLIAMS, J. H., WINNEK, P. S., and ENGLISH, J. P.: J. Am. Chem. Soc. 62:2002 (Aug.) 1940.
5. FEINSTONE, W. H., WILLIAMS, R. D., WOLFF, R. T., HUNTINGTON, E. and CROSSLEY, M. L.: Bull. Johns Hopkins Hosp. 67:427 (Dec.) 1940.

LEDERLE LABORATORIES, INC.
30 ROCKEFELLER PLAZA NEW YORK, N. Y.



BASED ON PUBLIC HEALTH REPORTS: 52:591 (May 7) 1937; 53:709 (May 6) 1938; 55:213 (Feb. 2) 1940; 56:1107 (May 23) 1941 56:1516 (July 25), 1941; 56:2015 (Oct. 10) 1941.

SULFADIAZINE IS MANUFACTURED IN BULK BY OUR AFFILIATE—CALCO CHEMICAL DIVISION OF AMERICAN CYANAMID COMPANY



More

THAN A GERMICIDE

A DETERGENT

A WETTING AGENT

AN EMOLLIENT

Zephiran

Trade Mark Reg. U. S. Pat. Off.

Brand of Benzyl-Trialkonium Chloride

BACTERIOLOGIC POTENCY is no longer the sole gauge of a germicide. Modern surgical technique has revealed a need for other values as well.

ZEPHIRAN is a mixture of high molecular alkyl-dimethyl-benzyl-ammonium chlorides. It contains no mercury, no phenol, no iodine, and is therefore free from the disadvantages of these drugs.

ZEPHIRAN is an active detergent. In addition to its unusual germicidal action ZEPHIRAN is a cleansing agent. It allows application by friction—a method not feasible with most antiseptics because of attendant irritation. Skin fats are emulsified, dirt and dead skin are rolled off, and the underlying tissue and bacteria may be more thoroughly subjected to the antiseptic.

ZEPHIRAN is a wetting agent. It does not merely coat or shellac the skin. It possesses a surface tension depressant action which permits more thorough penetration into the interstices and pores of the skin.

ZEPHIRAN is a soothing emollient. In 10,000 applications as a preoperative disinfectant and as a hand and arm soak, not a single case of skin or tissue irritation resulted. Leaves the skin soft, smooth, free from chapping or dermatitis.

For Preoperative Skin and Mucous Membrane Disinfection . . . Eye, Nose and Throat Antisepsis . . . Wet Dressings and Irrigations . . . Bladder Lavages . . . Fungous and Bacterial Infections . . . Vaginal and Urethral Irrigations . . . Surgeons' Hand and Arm Soak.

Samples and Literature Sent Free on Request

TINTED TINCTURE 1:1000, STAINLESS TINCTURE 1:1000, AQUEOUS SOLUTION 1:1000, 8 OZ. AND 1 GAL. BOTTLES

ALBA PHARMACEUTICAL COMPANY, INC., 74 LAIGHT ST. NEW YORK, N. Y.

From Ether Frolics to Anesthesia

The first surgical operation under ether anesthesia, at Jefferson, Ga., March 30, 1842, performed by Crawford W. Long. Three of the spectators were medical students. Painting by Maurice Siegler, 1935. Loan, courtesy of Dr. Frank Boland, Atlanta, Ga.

IN THE 30's and 40's of the last century ether frolics were a common pastime of young people . . . and in their hilarity the participants were often injured, yet felt no pain. It was this observation that led Dr. Crawford W. Long to persuade a friend to have a tumor of the neck removed under the influence of ether vapor. The operation was performed one hundred years ago . . . on March 30, 1842 . . . successfully and without pain.

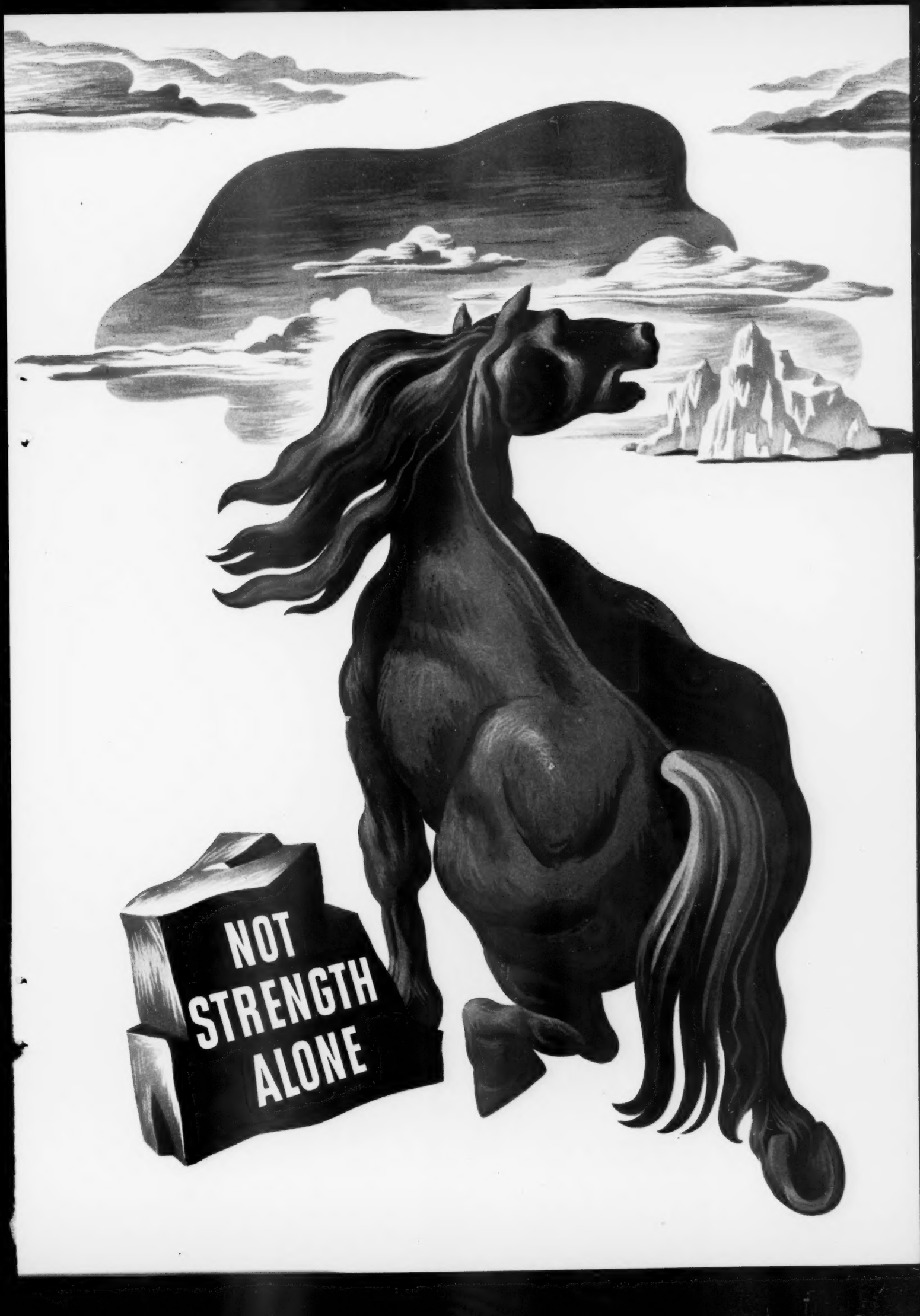
Thus it was that modern anesthesia developed from the chance discovery that a social custom had most important medical significance. Widespread recognition of the anesthetic properties of ether came in 1846 when Dr. W. T. G. Morton, working independently, gave the first public demonstration, in Boston, of the use of this anesthetic agent.

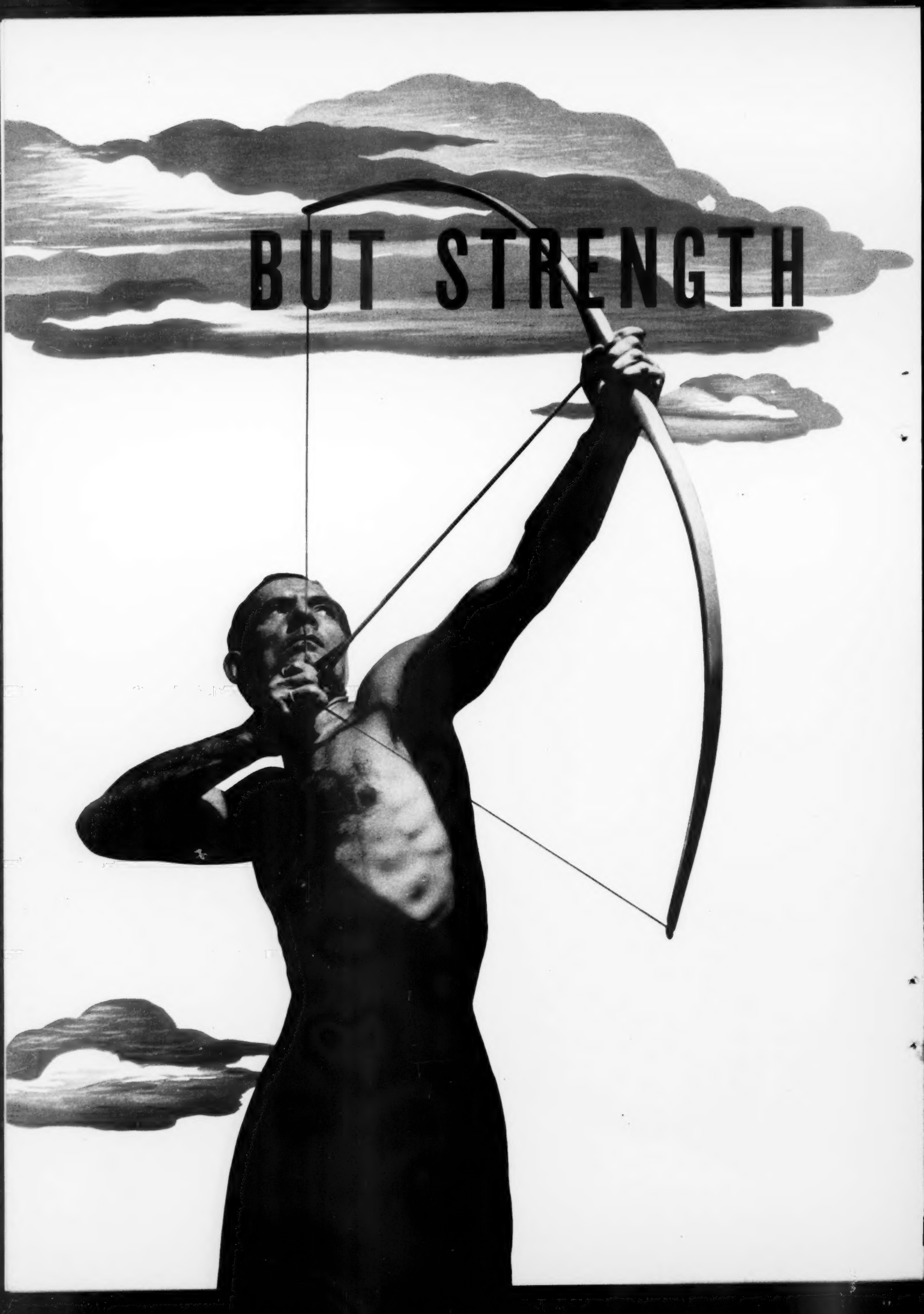
The difficulty then, as surgeons soon discovered, was to obtain a satisfactory ether. This problem was solved in 1853 when Dr. E. R. Squibb perfected his process for the continuous steam distillation of ether. So painstakingly had he studied the conditions requisite to making pure anesthetic ether that today, eighty-nine years later, the same essential methods are employed in preparing Squibb Ether, renowned for its reliability.

Because of Dr. Squibb's profound contribution to the development of anesthesia it is particularly appropriate that the House of Squibb pay tribute to Dr. Long, Dr. Morton and others who played their roles in one of the greatest advances in medicine. The debt of gratitude owed to the early pioneers in the field of anesthesia can never be repaid. It is inconceivable to think of surgery today without the benefits of anesthesia.

E·R·SQUIBB & SONS, NEW YORK

MANUFACTURING CHEMISTS TO THE MEDICAL PROFESSION SINCE 1858


NOT
STRENGTH
ALONE


BUT STRENGTH

UNDER CONTROL

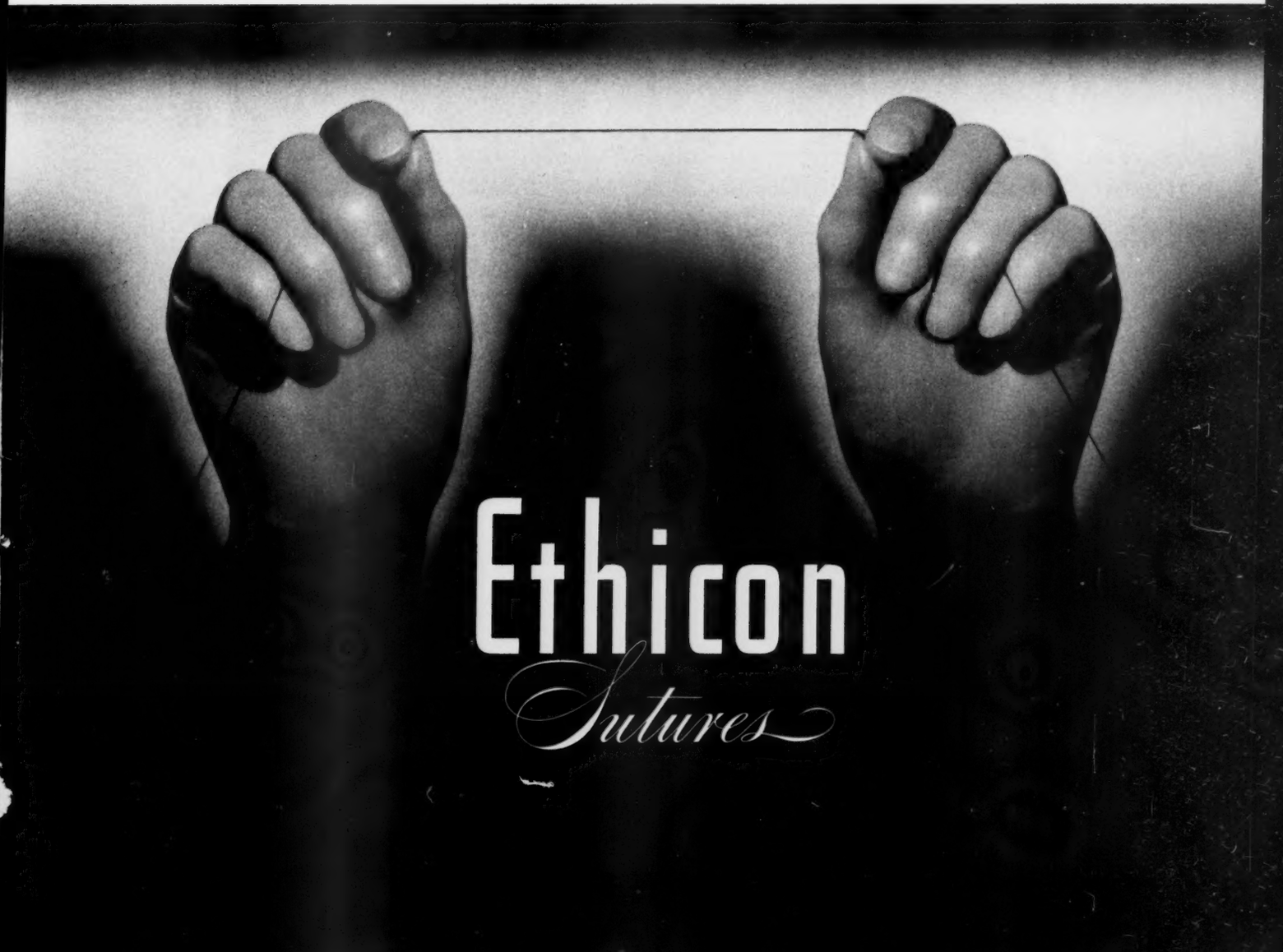
Not strength alone—rugged, unrestrained, variable—

but strength that is accurate, uniform, dependable. Of such is the

strength of Ethicon—assured by single-ownership production,

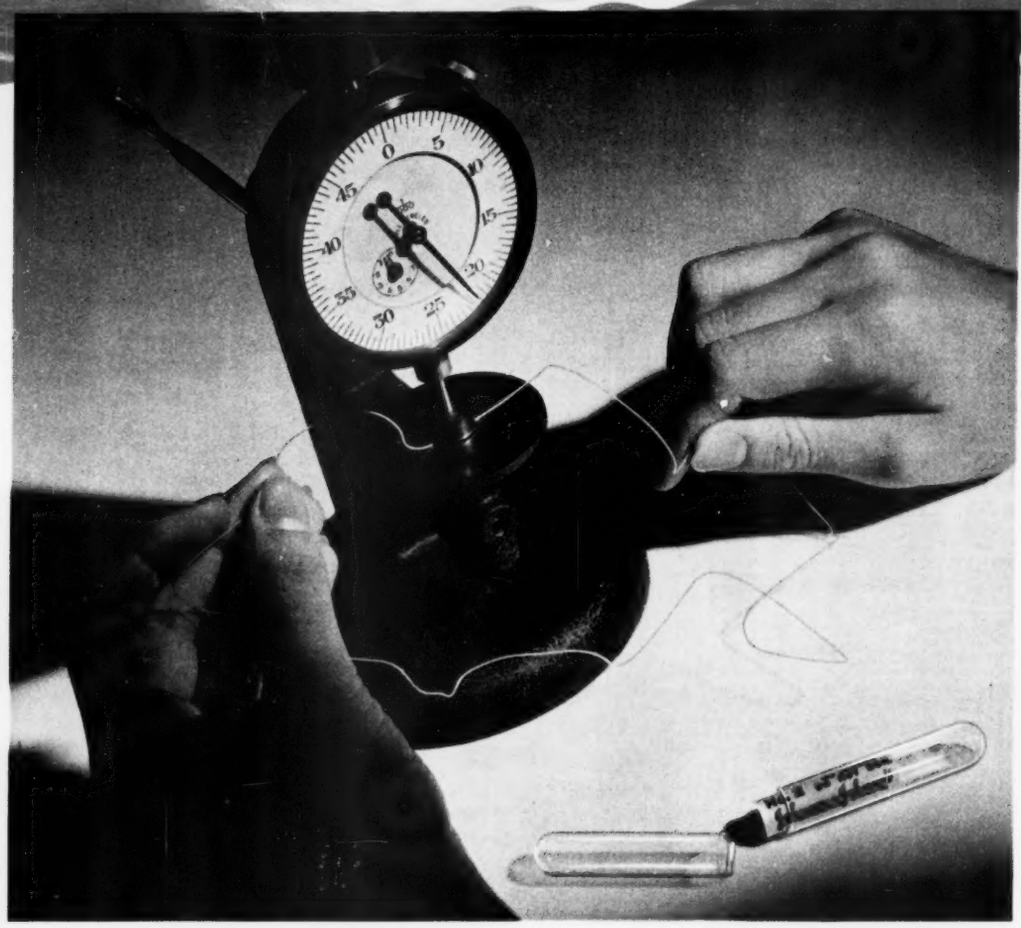
laboratory-supervised, from raw gut to finished strand. Ethicon is

exceptionally smooth, pliant, and, of course, conforms to U. S. P. standards.



Ethicon

Sutures



Not Strength Alone . . . But Uniformity of Strength. Ethicon Sutures combine maximum strength and minimum bulk, assuring the surgeon a suture that will hold tissue securely, yet involve the least possible amount of foreign substance in the tissue. Laboratory control of every process in the making of Ethicon results in sutures that are uniform in size and strength, worthy of the confidence of the surgeon who insists on the highest standards of material as well as of operating technique.

ETHICON SUTURE DIVISION

Johnson & Johnson

NEW BRUNSWICK, N. J. CHICAGO, ILL.

SUTURE MANUFACTURERS SINCE 1887

COPYRIGHT 1942, JOHNSON & JOHNSON

The American Journal of Surgery

Copyright, 1942 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

NEW SERIES VOL. LV MARCH, 1942 NUMBER THREE

Editorial

THE PRINCIPLE OF NATURAL SELECTION APPLIED TO THE GENESIS OF CANCER

ANY theory of cancer must harmonize the facts that cancer occurs in a higher incidence in civilized man than in native man, and in native man than in wild and domestic animals; that cancer does not occur in cells of the highest metabolism, such as the cells of the heart, the cells of the voluntary muscles and the cells of the brain; that cancer is rarely if ever spontaneously arrested; that cancer does not occur in the fetus, and occurs rarely in infancy and childhood; that cancer occurs commonly in middle life and increasingly with advancing age; that cancer does not occur in normal uninjured cells, but occurs after prolonged, repeated injury and repair due to mechanical, chemical, bacterial, electrical or radiation factors.

A general theory of cancer must harmonize the facts that cancer cells perform little or no physiological function; that cancer cells utilize all their energy solely for growth; that cancer tissue exhibits a higher electric capacity, electric conductivity and electric potential than the normal tissue in which the cancer appears;[1,2,3,4,5] that cancer tissue bears a different sign of charge from that of the adjacent normal tissue;[6] and that the nucleus of the cancer cell is relatively larger than the nucleus of the normal cell from which the cancer cell was derived.

A general theory of cancer must harmonize the fact that the growth *per se* of cancer is painless, in contrast with the defensive pain of infections.

It must also harmonize the fact that evolution did not favor the growth of cancer. Evolution favored the growth of the fetus by increasing the growth-stimulating secretions of thyroxin and pituitrin in the mother, by increasing the heart beat, the circulation of the blood, the metabolic rate and the appetite. In fact, the entire organism of the mother is stepped up to contribute to the growth of the fetus. Evolution contributed no such aid to the growth of cancer. Cancer has been blacklisted by evolution; the rest of the body does not collaborate in facilitating the speed of its growth.

A general theory of cancer must indicate a mechanism by which, through struggle and survival of the injured cells, a type of cell may be evolved which possesses the power of growth and little or no power of function; the theory must show that these cells within the area of injury and repair, through struggle and survival among themselves, may become the most power-

ful cells in the use of energy for growth alone.

A general theory of cancer must harmonize the fact that in the successful treatment of cancer by *x*-rays or radium, the electric conductivity, capacity and potential gradient of the malignant tissue decline to the level of the tissue in which the cancer grows, and coincidentally the cancer as a tumor disappears, and the great vascularity characteristic of cancer disappears.

The incidence of cancer is highly significant. In nature, cancer occurs rarely in wild and domestic animals, with possible exceptions in the dog and the horse, and in mice. Through breeding, man has modified the plant world and the world of domestic animals. In certain strains of laboratory mice, for instance, cancer appears in a high percentage of the animals. This fact does not conflict with the statement concerning the rarity of cancer in the animal world. On the other hand, it emphasizes the principle that cancer is produced by universal biological forces. Obviously, these cancerous animals represent modifications of the natural state by breeding.

Cancer is relatively rare among primitive races. Although, as stated by Hoffman, there are practical difficulties in determining the causes of death among noncivilized races, yet it is the opinion of qualified medical observers that among primitive peoples cancer is not met with to anything like the degree common to practically all civilized countries.

Cancer is rarely seen in the younger age groups of mankind. It seldom occurs in fetal life, in infancy, in childhood or in adolescence. With advancing age, cancer appears in man in a gradually increasing percentage until senility and death.

Cancer does not occur in tissues making up perhaps three-fourths of the human body. It is not found in the entire mass of voluntary muscle fibers, or in smooth muscle fibers. It is not found in the blood, in either red corpuscles or white corpuscles. Cancer does not appear in nerve cells; it is not seen, for instance, in cells of the cortex of the brain. But cancer does appear in epithelial cells, in connective tissue, in bone, in fact in all the other tissues of the body.

Furthermore, normal, uninjured cells do not spontaneously become cancer cells. The highest authorities, from the time of Billroth to the present day, are in agreement with this statement. This is not inconsistent with the fact that benign tumors, especially the adenomas, not infrequently become cancer, since the cells of the benign tumors are not normal cells.

Now, each normal cell is in electrical equilibrium with the adjacent cells.

We will consider that the cancer cell is a normal epithelial cell that has lost its electrostatic balance with its neighboring cells, hence exists as an independent biologic unit; that in the process it has lost nearly all of its power of function and has gained an increased power of growth; that the individual cells under continued mechanical, chemical, bacterial, electrical or radiation stimulation, types of stimulation exerted singly or in combination, are subjected to injury and repair; and that in the cellular melee of struggle and survival natural selection offers to the fittest cell the entire body of man for its endless growth.

In this genesis, the establishment of a single cancer cell would be analogous to the introduction of a deadly germ, a single virulent bacterium, into the body.

When a local area is subjected to mechanical, chemical, bacterial, electrical or radiation injury, electric currents are induced, and these persist until repair is established. The "current of injury" would seem to be an important factor in the repair of injured cells. We are now in possession of a new fact which assigns to the "current of injury" a definite source and a more probable relation to growth and repair.

The brain and other nerve tissues bear a positive sign of charge, and all other

tissues of the body bear a negative sign of charge. The production of the positive ions in the brain is due to oxidation. What then is the source of the negative ions which constitute the "current of injury"?

I postulate that the heart and the red blood cells constitute the source of the negative ions. A basic fact supporting this hypothesis is the thickness of the film surrounding the red blood cell. Fricke[7] in our laboratories determined that the thickness of this film is on the order of 1/2,500,000 cm., approximately that of a molecule of oil. This lipoid film because of its extreme thinness is ideally adapted for holding static electricity. The question arises, what is the source of this static electricity?

There is a principle that a particle moving through air or through water accumulates static electricity in relation to the speed of movement and the amount of friction. Examples of this principle are seen in the formation of dust in which wind is the source of friction. Another example of this principle was observed by Lenard in Switzerland in 1892, when he detected that the particles of water passing through the air in a waterfall took on negative charge.

I postulate that this principle of the accumulation of charge of static electricity by particles moving through air or water is equally applicable to the red blood cells. The left ventricle, in its contraction, through friction and speed of movement would cause a charge-up of static electricity on the films surrounding the red blood cells. As the blood moves from the high velocity in the left ventricle through the branches of the arterial tree to the capillaries, there would be a distribution of this static negative electricity held on the films surrounding the red blood cells. As the red blood cells slowly squeeze their way through the capillaries they would distribute the greater part of their negative charge to the adjacent tissues. Thus with each heart beat there would be distributed through the red blood cells, or accumulators, a quantum of electric charge to every microscopic unit of living tissue.

In testing this hypothesis experiments were performed upon 377 animals in our laboratories.[8,9] It was found that during life there existed an electrical potential gradient between the brain as the positive pole and the blood as the negative pole. Each heart beat caused an increase in the difference in potential. Each increase in the force and frequency of the heart beat correspondingly increased the difference in potential. When the flow of venous blood was completely interrupted at the point of entering the right auricle, the difference in potential decreased abruptly. On arrest of the heart, the potential gradient dropped almost instantly to the death level. Throughout living tissue, there is the universal presence of potential gradients.

Not only the life, but the growth and repair of tissue is dependent upon the presence of potential gradients. In other words, the universal source of the energy of growth and repair is the negative or static charge on the red blood cells. The greater the requirement for growth and repair, therefore, the greater the need of vascularization.

This agrees with the clinical fact that in a local area of repeated, long-continued injury and repair, there is a concomitant increase in vascularization. This increased capillary circulation brings a corresponding increase in the negative potential brought to the injured area by the increased number of red blood cells. As a consequence, there is established in the area of injury an increased electrical conductivity, electrical capacity and electrical potential, which in turn increase the power of tissue repair. In fact, the increased electrical conductivity, electrical capacity and electrical potential are the principal source of the power of growth and repair. In short, the "current of injury" tends to reconstruct the injured cells. But if the structure of a given cell is injured to the extent that the mechanism for function is lost, the cell reconstructed by the "current

of injury" would possess only the mechanism for growth. Thus a cancer cell would be evolved.

This hypothesis is consistent with the high incidence of cancer in civilized man as compared with native man. It is obvious that in warm-blooded animals there is a greater increase of vascularization in the course of injury and repair than in cold-blooded animals. Among warm-blooded animals there is a greater vascularization and power of repair in the northern climates than in the tropics. The vigor of the man in the north is an adaptation to cold. The organs of adaptation to cold are the brain, the thyroid gland, the heart and the blood volume. Thus the larger brain, larger thyroid gland, larger heart and blood volume, the neuro-endocrine formula of civilized man, offer a greater vascularization, hence a greater "current of injury," hence a greater power of growth and repair in man in the temperate zones than in man in the tropics.

A consequence of this greater power of repair in man in the temperate zone is that injured epithelial cells will receive more effective electrical stimulation, hence will be more effectively restored, in the vigorous civilized man of the north than in the native of the tropics.

Thus the incidence of cancer in civilized man is higher than in tropical man. Civilized man lives longer than native man. Civilized man excels native man in intelligence, power and personality. Not only cancer, but also exophthalmic goiter, peptic ulcer, diabetes, and nervous and mental diseases, all reflecting overdevelopment of the energy-controlling organs, are higher in civilized man than in native man.

In the melee of injury, then, in the presence of electrical forces influencing repair and growth, vast numbers of epithelial cells are partially or completely destroyed and many are repaired. These individual cells undergo struggle and survival, just as animals undergo struggle and survival in the vicissitudes of life and the fittest cells survive. At some point it may happen that one cell becomes possessed of a larger nucleus than is possessed by a normal cell. This cell that possesses a larger nucleus may have suffered such great damage to the cytoplasm that it has lost that mechanism in the cytoplasm by which it performed its function. The new cell would have, accordingly, a high growth energy, for none of the energy of the cell is expended for function, and all of it is expended for growth. This cancer cell is the epithelial cell that has gone through the struggle in the area of injury and repair and has emerged as the fittest cell for growth only. In other words, we can apply the principle of natural selection through struggle and survival among individual cells in the process of injury and repair, in an interpretation of the origin of cancer.

It has been stated that among the living normal cells of organs and tissues there is an electrostatic equilibrium, and that the "current of injury"[10] sets up a difference in potential between the injured cells and the normal cells. Moreover, when an adenoma appears, as for instance in a thyroid gland, there is also a difference in potential between the adenoma and the adjacent normal tissue, and an electric strain is established. In many cases benign tumors are thus situated in the midst of normal tissue under unequal electric equilibrium and with electric strain between the benign tumor and the normal tissue. As a result of this electric strain, cancer may be produced, not in the normal tissue but in the benign tumor. Similarly, if two metals of different atomic weight are used in filling a tooth, there will be set up electric currents between them which will ultimately destroy the tooth. Theoretically, this electric strain would cause cancer at the base of the tooth.

Whereas no normal cell has a biological career of its own and no normal cell can metastasize, the cancer cell in its freedom metastasizes through the lymphatic channels and sometimes through the blood stream. And since that cancer cell as an

individual is adapted to the chemical affinities of the whole organism, it can grow anywhere.

It has become detached from the electrostatic and physical state of its fixed position in relation to adjacent cells, and by a process of devolution has returned to the level of its unicellular ancestor, which existed eons ago. This cell, having lost the mechanism in its cytoplasm by which it performed its function, and possessing now the power of growth only, exists as a biological unit. This independent cell, like its ancient progenitor, has the power of assimilating food, of respiration, of growth, of metabolism and cell division.

Only rarely does it retain to some extent the function for which it was evolved. The mechanism by which the function of a cell is performed is more recent in phylogeny than the primordial mechanism of the unicellular ancestor that was evolved for growth and cell division only. It is clear that the formula of growth and cell division is more basic than the specialization of the cytoplasm for function.

There is definite evidence that the mechanism which effects the maintenance and growth of all cells exhibits a lower stage of evolution than the mechanism of function. This evidence is seen in the fact that the mechanism of growth is more resistant than the mechanism of function.

For instance, in the repeated injury and repair of skin of the hands and arms, the cells of the skin exhibit a loss of function, as seen in loss of sweat glands and in loss of softness. Many cells are destroyed and replaced by scar tissue. In the course of months or years, the growth mechanism steadily increases in the cells of the skin. With repeated generation of unbalance between the growth mechanism and the functional mechanism, the cells finally lose completely the mechanism of function and keep the ancient unicellular mechanism of growth only.

Moreover, *x*-ray or radium application may be so adjusted as to suspend or destroy the mechanism of cellular function and not destroy the mechanism of cellular growth. This is seen in radiation of the salivary glands.

The beginning of specialized function in the unicellular organism is exemplified in the diplodinium. In the diplodinium the nucleus is evolved as a diminutive brain, and from this nuclear brain, nerve fibers extend to the base of the flagellae. The flagellae are the antecedents of the arms and legs and wings of the higher animals. The specialized nucleus and the nerve communications to the flagellae are the analogue of the brain and the nervous system of the higher animals and man. In other words, in man the brain is the exalted nucleus of the diplodinium. The spinal cord and nerve fibers in man are the exalted simple nerve communications between the nucleus and the flagellae in the diplodinium.

From the diplodinium throughout the multicellular animals, increasingly higher degrees of specialization were evolved, culminating in man. In man, indeed, many cells have become so highly specialized, and exist under such special conditions, that they have lost their ancestral basic mechanism of growth and cell division only. A large part of the body of man is constituted of cells so specialized that under the most extreme degree of chronic mechanical, chemical, bacterial, radiation or electrical injury, they cannot lose their specialized function and exist as cells with the power of growth only; they cannot be reduced to cancer cells. Among the cells that cannot be reduced to cancer cells are the twenty-five trillions of red blood cells. Among the cells that cannot be reduced to cancer cells are those that comprise the entire voluntary and involuntary muscular system. Among the cells that cannot be reduced to cancer cells are the nerve cells, including the trillions of cortical brain cells of man.

The red blood cells possess no nucleus. Their protoplasm is maintained and their function is performed by the universal negative potential in the entire vascular

system, produced by the heart's contractions. Here electric strain exemplifies in the most perfect way the power of maintaining protoplasm and of performing function.

The voluntary muscles comprise by far the greater part of the weight of the body. They execute the greater part of the metabolism of the body; they perform the mechanical work of the body. They do the walking, running, fighting.

The muscle cell, or more correctly the muscle fiber, is indeed not a cell but an example of extreme specialization as the result of a nucleus-plasma evolution. The voluntary muscle fiber represents the protoplasmic evolution of the cytoplasm, just as the brain cell represents the evolution of the nucleus. The muscle fiber is the cytoplasmic partner of the brain cell, communicating with it by a nerve fiber. The brain cell and the muscle cell together constitute the most important physiological unit of the higher animals and man.

The close relation of the brain cell and the muscle fiber is simply demonstrated by severing the nerve communication between them. This is equivalent to taking apart the nucleus and the cytoplasm of the unicellular ancestor. Severing the nerve communication between a brain cell and a muscle fiber produces striking immediate and remote effects. The immediate effect is complete paralysis of the muscle fiber. The remote effect is the complete loss of the muscle fiber as a living entity. The function of the nucleus of the muscle fiber is so insignificant that it cannot be maintained. Therefore, chronic mechanical, chemical, bacterial, radiation or electrical injury of any degree or of any length of time cannot transform a single unit of the most massive, most powerful mechanism of the body into a cancer cell.

The same reasoning holds for the heart muscle and the smooth muscle fibers of the body. They cannot be reduced to the status of a cancer cell. Evolution has so specialized the voluntary muscle fibers, the heart muscle fibers, the involuntary muscle fibers, that they have lost their identity as cells with a nucleus-plasma relationship, and are incapable of sustaining themselves independently, much less of becoming cancer cells.

The positive electric stimulation of all these specialized muscle fibers is derived from the brain cells; the negative electric stimulation is derived from the friction in the movement of the red blood cells in the adjacent capillaries.

We have applied the principle of natural selection, struggle and survival to the life history of the cells of the body that may become cancer. Furthermore, we have put to experimental test the idea that cells may be reduced completely to a nonliving state, then reassembled as cells having all the characteristics of the ancient unicellular organisms.[11,12,13] Such reassembled cells would have lost their power of function and would retain only their power of growth.

The cancer cell, like every living cell, is made up of proteins, lipoids, and electrolytes. The brains of freshly killed normal animals were dried and ground up, the lipoid and protein fractions were extracted, and the ash, or electrolyte fraction, was obtained. These lipoid and protein fractions and a solution of the electrolytes were mixed together. Beautiful cells formed instantly; they grew, divided and exhibited respiration. They were killed by anesthetics, poisons and radiation. The respiration of these cells was increased by thyroid extract and iron. These cells emitted ultraviolet radiation during their formation. The only food that these autosynthetic cells could utilize was protein derived from the species which supplied the brain from which they were formed.

These cells continued to be active in cultures for eight months. The successive generations obeyed the laws of inheritance, the daughter cells resembling the mother cells.

In other words, in this experiment we took cells that had a highly specialized power of function but no power of growth,

and made of them cells that had no power of function but had the power of continuous growth.

It has been stated that cancer cannot develop in the organs of the highest metabolic activity, such as the brain, the heart and the voluntary muscles. In addition, cancer cannot grow at the expense of the tissue of highest potential.

Now it has been shown that the red blood cells carry negative charge, therefore electrically stimulate every microscopic tissue of the body, the stimulation being related to the degree of vascularity of the tissue. If this is true, then it would follow that the highest degree of energy in animals and in man would be found in the growth of the fetus. The growing fetus, through the highly vascularized placenta and through the highly vascularized new tissues in the process of formation, presents an example of the highest growth energy, therefore, the highest electrical stimulation from the blood stream. For a certain period after fertilization all the energy, radiant and electrical, is utilized for growth only. From an energy point of view, then, the fertilized ovum and the cancer cell proceed along parallel lines. But the growth energy of the fetus exceeds the growth energy of cancer. Therefore, cancer could not develop in the fetus.

The high vascularity incident to cancer tissue is analogous to the high vascularity of the placenta and fetus. In the case of the cancer as in the case of the fetus, the growth energy is supplied by the blood stream. The factor in the blood stream that produces growth energy in both the cancer and the fetus is the electrical stimulation supplied by the charged up red blood cells. Electrical stimulation is identical in nature, whether it causes the growth of the fetus or the growth of cancer.

Both the fertilized cell and the cancer cell have the power of growth and the power of cell division. In other words, each possesses a highly energized nucleus, hence a highly increased cellular potential. But the fertilized ovum and the "fertilized" epithelial cell are different in this respect: In the fertilized ovum there is the mechanism which eventually produces the organs and tissues of the fetus, the infant and the man. In the "fertilized" epithelial cell, there is neither in the nucleus nor in the cytoplasm any pattern of an organ or a man, but only the power of cell division and growth, as in the unicellular progenitor of millions of years ago, and as in the autosynthetic cell produced in the laboratory of the present day. The cancer cell possesses the formula of growth only; moreover, it possesses the pattern of rapid growth only. Whereas when the cells of the fetus, the child and the man are completely differentiated, the electrical potential supplied by the red blood cells is utilized for function and not for growth.

By means of the physical constants, electrical conductivity, electrical capacity, and electrical potential, we have studied cancer in man and animals. Our first biophysical investigation of cancer consisted of a series of comparative measurements of the electrical conductivity of normal and of pathological tissues. In this study we measured 219 sections from 159 clinical cases. These included malignant and benign tumors of the breast and of the uterus, ulcer and carcinoma of the stomach, carcinoma of the rectum, malignant and benign tumors of the mouth, jaws and neck, *x*-ray burns and various types of goiter, including hyperplasia, fetal adenoma, multiple adenoma, toxic adenoma, exophthalmic goiter, simple colloid goiter and thyroiditis. Whenever possible, adjacent normal tissue was measured for comparison. The pathological diagnosis and differentiation of different types of tissue in single specimens was made by a pathologist.

In all instances in which comparative measurements were made, the conductivity of the malignant growth was higher than that of a normal portion of the same organ.

The outer, growing parts of cancers showed a high conductivity in contrast with the conductivity of the central, nongrowing parts.

Among the goiters studied the highest conductivities were found in the degenerating adenomas and the malignant thyroids; the conductivities of the hyperplastic thyroids were lower; and the conductivities of the colloid goiters were the lowest of all the pathological tissues studied.

This line of inquiry was further extended, when the theoretical requirement that cancer tissue must have a high capacity for the storage of electric charges was tested. Eighty specimens from fifty-three cases were investigated, including fifteen carcinomas of various types, three sarcomas, three benign tumors, and sixteen goiters of various types. All of the carcinomas had a relatively high capacity in the actively growing portions of the growth. The degenerated portions of the growth had a lower capacity, and radiated tissues a much lower capacity. In every case studied the cancer itself had a higher capacity than the tissue in which the cancer had developed. This difference was particularly marked in the case of carcinomas of the breast, in which the capacity of the cancer was often over ten times as high as that of the adjacent glandular, connective or fatty tissue. Adenomas and hyperplastic thyroids had, as a rule, a higher capacity than the normal thyroid tissue. In general, glandular tissue seemed to show a somewhat higher capacity than normal tissue. Connective tissue had usually a very low value, and the capacity of fatty tissue was also low.

According to our conception, cancer cannot grow unless a difference in potential is maintained between the cancer mass and the surrounding tissue. Of special significance, therefore, was the finding that the electric potential of a cancer has an opposite sign of charge to that of the tissue in which it is growing, the degree of difference apparently varying with the malignancy of the growth.

In a series of experiments on rats, direct observations were made of the sign of charge of cancer. It was found that cancer exhibited a different sign of charge than that of the adjacent normal tissues. A series of experiments was performed in which a measured current of electricity and a solution of sodium chloride were so manipulated that by ionization the potential of the cancer became the same as that of the normal tissue surrounding it. The cancer diminished in size during the course of treatments with the electrodes placed in one position; by reversing the poles, we could cause the cancer to grow; and when the electrodes were again reversed, the cancer would again diminish. When the cancer potential was brought to and maintained at the level of the potential of the normal tissue, the cancer disappeared.

Such experiments were successful in about 30 per cent of the cases. These experiments are not conclusive, for they dealt with transplanted cancers in rats, which are rather easily cured and are not easily induced; but the results of the experiments cited are in harmony with our theory and support it.

The fact that cancer exhibits a different sign of charge from that of adjacent normal tissue agrees with our conception that cancer cannot grow unless a difference in potential is maintained between the cancer mass and the surrounding tissue. This conception is in accord with certain clinical facts. When muscles are repeatedly stimulated electrically, they increase in size. If the motor nerve supplying a muscle is divided, the continuous bio-electric current is shut off and the muscle atrophies. Exercise of all kinds is the equivalent of electrical stimulation. Electrical stimulation increases electrical potential. Electrical stimulation and electrical potential are related to the growth of protoplasm.

Moreover, when two tissue cells are in biological contact, the cell having the higher potential controls the cell having the lower potential. Therefore, a cancer cell can invade—can overcome—no cell that has a higher metabolism than its own.

Our findings, therefore, support the conception that a fertilized ovum would act as a cancer if the ovum were in contact with ordinary cancer, that the ovum would,

theoretically, overcome the cancer just as cancer cells overcome the neighboring cells of lower activity.

Our findings support the clinical observation that in adults, cancer does not develop among cells of a high electric potential, that cancer does not originate in the cellular units of the gray matter of the brain, the heart muscles, the voluntary muscles or the involuntary muscles; for the metabolism and the potential of the cells of these tissues are higher than those of cancer cells.

True, cancers are seen in the organs in which these tissues are found, but the cancer cells originate not in the highly metabolic cells of these organs but rather in the connective tissue cells and other cells of lower metabolism. The epithelial cells that cover or line the surface of the body, of the hollow organs and of their ducts, do not have a high metabolism, hence these cells are the frequent hosts of cancer.

It would seem that the principle of natural selection, as applied to the struggle and survival of individual cells in the zone of prolonged, repeated mechanical, chemical, infectious, electrical or radiation injury, explains many of the facts associated with cancer. It agrees with the conception that the "current of injury" and the power of repair by the electric forces in the tissues are established by the heart and the red blood cells and the vascular tree in their rôle of an electrostatic generating system. It explains the establishment of a characteristic difference between cancer and normal tissue, in electrical capacity, electrical conductivity and electrical potential, in the precancer as well as in the cancer stage. It explains the high incidence of cancer in civilized man, as compared with native man and wild and domestic animals.

Finally, this theory is in harmony with the fundamental conception that cancer obeys biologic laws: By the process of devolution, the cancer cell, like the autosynthetic cell of the laboratory, has lost the power of function and retains only the power of growth. It has reverted to the primordial pattern of the ancient unicellular ancestor of animals and man.

The production of autosynthetic cells in the laboratory has been described. This suggests a clinical analogy. Not only might physical injury cause a cell to be built up to the level of a cancer cell as a result of an induced potential, but if numbers of cells are reduced to their protein and lipoid fractions, then by an autosynthesis, new cells may be formed out of the material. Thus, as with fertilization in the production of the whole animal, cells endowed with the vigor of growth only may be produced. This autosynthesis also would be aided by the stray electric or injury currents.

Thus the occasional sarcoma of the thigh which follows a single crushing injury of all the soft parts down to the bone, leaving the skin intact, might be explained as due to autosynthesis. It is significant that this sarcoma sequence occurs only after a heavy blow or extensive crushing. This is comparable to the incidence of sarcoma in bone following a single blow, or in tissues which have not been lacerated and have incurred no infection; there has been no interference with Nature's biologic cover, so that there is no interference with the fullest development of bio-electric currents.

George Crile, M.D.

REFERENCES

1. Crile, George. Electric conductivity observations on malignant and benign tumors, with a further note on operations for cancer of the large intestine. *Tr. Southb. S.A.*, 33: 149, 1921.
2. Crile, George, Hosmer, H. R. and Rowland, A. F. The electrical conductivity of animal tissues under normal and pathological conditions. *Am. J. Physiol.*, 60: 59, 1922.
3. Crile, George. An electro-chemical theory of normal and certain pathological processes. *Proc. Am. Philosoph. Soc.*, 60: 346, 1921, also in *Bull. M. & Chir. Fac. Maryland*, 14: 21, 1921.
4. Fricke, Hugo and Morse, Sterne. Measurement of electric capacity of tissues of the breast. *J. Cancer Research*, 10: 340, 1926.
5. Crile, George. A Bipolar Theory of Living Processes. Chap. 8. New York, 1926. The Macmillan Company.
6. A theoretical conception of the mechanism by which a normal cell is changed to a cancer cell. *Acta, Union internat. contre cancer*, 2: 362, 1937.

7. Fricke, Hugo. Electric capacity of suspensions of red corpuscles of a dog. *Physical Rev.*, 26: 682, 1925.
8. Crile, George, Glasser, Otto and Quiring, D. P. The heart and the red blood cells as generator and distributors of static electricity. *Obio J. Sc.*, 41: 347, 1941.
9. Crile, George. Intelligence, Power and Personality. Chap. 2. New York, 1941. Whittlesey House.
10. Crile, George, Telkes, Maria and Rowland, A. F. An investigation of the physical nature of cancer cells. *Am. J. Cancer*, 15: 2659, 1931.
11. Crile, George. Research into the formation of autosynthetic cells, with special reference to fertilization, production and growth of cancer cells and the cause of fatty degeneration. (Wm. Potter Memorial Lecture) *Am. J. Surg.*, 12: 213, 1931.
12. Crile, George, Telkes, Maria and Rowland, A. F. Autosynthetic cells. *Protoplasma*, 15: 337, 1932.
13. Crile, George, Telkes, Maria and Rowland, A. F. The nature of living cells, with special reference to the nature of fatty degeneration. *Arch. Surg.*, 23: 703, 1931; also in *Cleveland Clinic Quart.*, 1: 3, 1932.

CONSERVATION OF SCHOLARLY JOURNALS

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems and hopes that American scholars and scientists will be of considerable aid in the solution of one of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests received by the Committee already give evidence that it will be enormous.

With an imminent paper shortage attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the co-operation of subscribers to this journal in preventing the sacrifice of this type of material to the pulp demand. It is scarcely necessary to mention the appreciation of foreign institutions and scholars for this activity.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to Wayne M. Hartwell, Executive Assistant to the Committee on Aid to Libraries in War Areas, Rush Rhees Library, University of Rochester, New York.

Original Articles

REDUCED TEMPERATURES IN SURGERY*

III. EXPERIMENTS ON PELVIC AND ABDOMINAL REFRIGERATION WITH ESPECIAL REFERENCE TO TRAUMATIC AND MILITARY SURGERY

FREDERICK M. ALLEN, M.D.
Department of Physiology and Biochemistry,
New York Medical College
NEW YORK, NEW YORK

THE advantages hoped for from refrigeration in amputations for gangrene are ease and quickness, absence of pain both during and after operation, inhibition of infection, conservation of poorly nourished tissues, control of edema, promotion of drainage when necessary, probable reduction of thrombotic and embolic dangers, and pre-eminently the avoidance of shock.[1] Transfer of these results to war conditions offers hope of transportation of limb casualties without hemorrhage, pain or shock, without advance of infection or tissue devitalization, with minimum damage and maximum time limits of tourniquet application and with freedom to operate without an anesthetic or to delay for several hours according to the exigencies of a crowded surgical service. As regards practicability, refrigeration is usually available on naval vessels, and for modern mechanized armies a 200 pound apparatus is obtainable, which can be operated by the motor of a truck or ambulance and can refrigerate four to six limbs simultaneously. Ice is frequently available in less fortunate countries, from Finland to China, where the lack of anesthetics has entailed much suffering. Many experiments are needed to test the validity of these hopes. Existing conditions seem particularly to demand investigation as to how far refrigeration can be serviceable in traumatic and military surgery.

With reference to the urgent problem of military surgery of limbs, the observations of Brooks and Duncan (cf. discussion of paper of Bancroft and Ruggiero, meeting of Southern Surgical Association, December, 1941) may be correlated with other existing information as follows:

1. The first work of Brooks and Duncan[8] was a confirmation, in rats' tails, of my previously published observations on legs of various species. There is full agreement concerning the absence of harm to normal limb or tail tissues from temperatures slightly above freezing, unless perhaps when continued for several days. Pressure being recognized as harmful, these authors avoided the localized injury of a tourniquet by extending the pressure over the entire tail. Therefore, even the slight atrophy following several days without circulation was a result of cold plus pressure, and no injury from cold alone has yet been clearly demonstrated.

2. Recently, Brooks and Duncan[9] used a skin patch test to show that when a staphylococcus culture or an aseptic irritant (turpen-

*Aided by a grant from the Committee on Scientific Research of the American Medical Association. With pathological observations by Dr. W. E. Youland, Department of Pathology, New York Medical College.

tine) is injected intradermally, the local effects are repressed by cold and augmented by heat; but when the cold is withdrawn after two days, the extent of injury is greater than in control patches left at normal temperature. As such experiments do not disprove the benefits of hot applications for infections under proper conditions, so also they must be interpreted in regard to cold according to existing broader information, as follows:

(*a*) Gangrene being the object of my study, rattlesnake venom was used[10] for producing an aseptic wet gangrene with an extreme tendency to spread and become infected. Cold could inhibit this process but could not stop the spread of the poison.*

(*b*) Temporary chilling of the peritoneum[11] was found to lower its resistance to an injection of Staphylococcus albus culture.

(*c*) When a badly infected limb is subjected to the tourniquet and refrigeration for an extremely long time (e.g., twenty-four to forty-eight hours), the restoration of circulation may be followed by a rapidly fatal gangrene indicating a wide diffusion of bacterial toxin during the chilling.[1,12]

3. Although these possibilities of altered tissue permeability and of harm from wrong use of cold have been continually considered in both our experimental and clinical work, actual clinical experience comprises the following:

(*a*) The published reports of Temple Fay, McElvenny and others showing benefit and not harm from local cold applications for long periods without a tourniquet.

(*b*) Unpublished cases of embolism (Hurley) or arteriosclerosis and infection (McElvenny) in which the patients were treated with continuous ice packs for ten to thirty days, with favorable results. These cases furnish the only information yet available on anemic tissues subjected to very prolonged cold without pressure.

(*c*) Absence of microscopic damage in legs amputated after refrigeration, and benefit instead of injury clinically in the stumps (Crossman, Lisa).

(*d*) A poorly nourished edematous leg, bearing a very large, old, infected ulcer, on Dr. Crossman's service, to which I applied tourniquet and refrigeration for six hours, then released for observation of the effects. No tissue injury or extension of the ulcer or infection was perceptible clinically or in the pathological examination of the leg amputated four days later.

4. The skin patch experiments fail to cover the following practical applications of refrigeration:

(*a*) The Fay method of applying cold without tourniquet continuously until the infection or other morbid process comes to an end.

(*b*) The previously discussed[1] local and constitutional injury and shock from accident or operation, of such severe degree that they cannot be overcome by the unaided bodily powers as easily as a skin prick.

(*c*) The states of impaired circulation and vitality represented in arteriosclerotic limbs or traumatized areas, in which the lowering of metabolism by cold was designed to compensate for the reduced nutritive supply.

5. The temporary emergency uses of cold are among the most important, for example:

(*a*) To check pain, shock, infection, etc., during transportation or preparation for operation.

(*b*) To gain time for transfusion and other restorative measures.

(*c*) Theoretically, to provide opportunities which were very inadequately tested in experiments[12] such as stopping toxic absorption while antitoxin is injected either systemically or locally.

Brooks and Duncan's observations are not out of harmony with these numerous facts and need not create apprehension concerning any proper use of refrigeration.

Starting with the above mentioned experience with leg operations, it seems clear that both arms or both legs can be amputated as high as a tourniquet can be placed. One of the greatest benefits to be expected is the reduction of shock to a minimum. If a tourniquet is needed not for amputation but for temporary stopping of hemorrhage, it is known from animal experiments that one or several limbs can

* The spread of jungle fighting may introduce snake bite as a minor war casualty. This research emphasized the uselessness or actual harm of the temporary or intermittent tourniquets which most doctors are still disposed to use. Antivenine being seldom at hand in the emergency, it should be understood that bites on the limbs (which are more than 90 per cent of the total number) need never be fatal if a proper selection is made among the surgical treatments of (*a*) incision and suction, (*b*) wide excision, and (*c*) permanent tourniquet followed by amputation (best with refrigeration but feasible also without).

be safely deprived of circulation with the aid of refrigeration, and the efficiency of the chilling will determine the time limits and the prevention of tissue devitalization or infectious developments.

When the injury is too high to permit of a tourniquet, the bleeding vessels can be hastily clamped or tied and the wounded area refrigerated with ice or apparatus. This was the procedure by which McElvenny,[2] in a case of amputation of both legs by a railway train, controlled pain and infection for three days until the moribund patient could be restored sufficiently to undergo operation.

In proceeding beyond the limbs, there is the possibility of prolonged treatment by the method of Temple Fay,[3] who has demonstrated that local chilling can be used in practically any region, including the central nervous system, and can be continued for days, weeks or months. The possibilities of this method for infectious and other conditions are not yet fully ascertained or appreciated. The brief drastic refrigeration which includes the use of a tourniquet can be extended beyond the limbs only by studying two problems. One of these is a question of the total mass or proportion of bodily tissue which can thus be chilled into a state of suspended animation without fatal shock or other dangers. The other concerns the tolerance of different individual organs for cold and absence of circulation. This combination is impossible for the central nervous system, but appears to be harmless for peripheral nerves and ganglia. A series of unpublished experiments performed on dogs and cats with the co-operation of Dr. George L. Birnbaum indicated that the lungs are absolutely intolerant of ligation with chilling. On the other hand I found in a few trials that the thyroid readily endures both simple chilling and ligation with chilling for a number of hours, so that there is a theoretical hope that cold may become a useful aid in the stormy period of some operations for toxic goiter.

The principal part of the trunk to which refrigeration can possibly be applied is the abdomen. There is good reason for an advance assumption that the various abdominal organs will differ in their individual tolerance. Also it is necessary to consider closure of the abdominal aorta and the reduction of something like half the total body mass to a state of frigid inanition. This use of cold is not for anesthesia, as in the case of the limbs, because an abdominal tourniquet is distressing and is practicable chiefly in unconscious or previously anesthetized patients. The emergencies for which such heroic treatment may be contemplated are essentially three:

(*a*) *Hemorrhage.* The use of an abdominal tourniquet when all other measures are unavailing is not theoretical but has been familiar especially to obstetricians. Not only is bleeding instantly stopped in the lower part of the body, but also in the upper part there is a rise of blood pressure, a reduction of the demand upon the heart and vasomotor system, and an increased effectiveness of transfusions and restorative measures.

(*b*) *Shock.* Wounds or burns may be of such degree as to be fatal without treatment, yet the patient will die of the added shock entailed by operation. The tourniquet and refrigeration offer immediate blocking of both nerve impulses and chemical sources of shock, allowing an interval for both operation and recuperation.

(*c*) *Infection.* Examples are the rapid growth of gas-forming and other bacteria in mangled tissues, and the flooding of the peritoneum with the contents of ruptured intestines. Both the beginning infection and the toxic absorption can be checked if refrigeration is feasible.

The use of an abdominal tourniquet alone, without refrigeration, has been limited by three kinds of harm or danger:

(1) *Shock and Intoxication.* An abdominal tourniquet applied for one and one-half to two hours will cause fatal shock in a rat. The time limit for survival in dog and man is several times this period, though not determined exactly. These limits are greatly

shortened by pre-existing shock, and any relief gained during the brief period of tourniquet application will be more than counterbalanced by the increment of shock following release of the tourniquet. Furthermore, in the case of extensive wounds and infections, the accumulation of toxic products of devitalized tissues and bacterial activity contraindicates the method unless for the briefest period.

(2) *Paraplegia.* The degree and duration of paralysis are in proportion to the duration of tourniquet application, and may with long application be serious.

(3) *Organic Injury.* Care is necessary that no solid organ be caught in the grip of the tourniquet, because the injury may be dangerous. The intestine tolerates the pressure safely for a short time, but continuance for several hours sometimes leads to perforation.

The changes introduced by low temperature and the entire question of the feasibility of refrigeration in the abdomen, require investigation by animal experiments. Observations on cats proved the species to be unsuited for the purpose because of special sensitiveness. The main mass of the experiments were, therefore, performed on dogs, which as usual react more like man.

METHODS

All animals were under nembutal anesthesia. The experiments are divided into low and high abdominal ligations, and these again subdivided into those with closed or open abdomen. These important differences of level in the dog's abdomen are impossible to duplicate with an external tourniquet in man.

For the closed type of experiments, a narrow tourniquet in the form of two or more superimposed turns of a strong elastic rubber tube is applied either close above the pelvis or close below the ribs. In the former case the animal is suspended by the hind legs, in order that the free portion of the intestine may fall toward the diaphragm and thus not be included in the ligation. For application of the high tourniquet the animal is suspended by the forelegs, in order that the main mass of the intestine may be included in the area cut off from circulation.

The hind parts are then buried in crushed ice up to a point an inch or two anterior to the tourniquet. It is possible instead to place the animal vertically in ice-water, but this position involves more strain and greater difficulty in keeping the anterior parts warm. The hair of a dog or cat interferes with chilling or even wetting of the skin. Shaving of such a large area is troublesome and also creates inconvenience in keeping the animal warm after the experiment. Therefore, immediately after application of the tourniquet the hind parts have been rubbed with a solution of green soap just before putting on the ice. The fore parts are covered warmly and also heated by hot water bags or electric pads.

Temperatures have been taken with a long laboratory type of thermometer inserted occasionally into the rectum or esophagus. The endeavor is to keep the parts anterior to the tourniquet at normal temperature, and those posterior to the tourniquet at the lowest possible temperature above actual freezing. No refrigerating blanket or other artificial device can match the close contact of ice or ice-water with the skin; nevertheless the chilling of the large tissue masses is slow and unsatisfactory in the animals and must be still more so in man. In cats the rectal temperatures have approximated 60 to 66°F. (15 to 18°C.) at the end of one hour and 50 to 56°F. (10 to 13°C.) at the end of two hours. The dogs used have been small, about 4 to 8 kg. in weight, and owing to their greater size the temperatures tended to fall a little more slowly than in the cats.

Perfusion with ice-cold Ringer solution or plasma might promise ideal refrigeration, but a few trials indicated that chilled tissues are like dead tissues in resistance to perfusion. A considerable quantity of fluid can be injected slowly into a main artery, but very little of it returns from either the

artery or the vein; also there is very little flushing out of the blood which is known to be locked up in an unclotted state somewhere in the vessels.

Recourse was next had to injections of iced physiological saline intraperitoneally, intramuscularly and subcutaneously. Extreme variations in quantity were tried without establishing an optimum. A dog has been given as much as one-third of its own weight of salt solution, making the abdomen tense almost to bursting, the rectal mucous membrane protuberant and the skin and tissues of the flanks and thighs tightly stretched. The insertion of needles or cannulas does not provide rapid or thorough drainage for such injections. The presence of such a mass of fluid under such tension has not resulted in any noticeable harm at the low temperature. It has not prevented the return of circulation, though theoretically there is a disadvantage in the larger cold mass which must be warmed by the returning blood. Even though the abundant saline may be an aid against shock, there is this added chill of the entire body. Therefore, intraperitoneal injections of 200 to 500 cc. of iced saline have commonly been used in the attempt to reduce the rectal temperature below 50°F. or 20°C. within the first hour. After that the external cold suffices for a further slow and progressive reduction of temperature. Even under the best conditions, the experiments with closed abdomen never furnished the ideal temperatures for preservation of tissue and prevention of shock.

The experiments with open abdomen may be of various kinds and degrees. An incision may be made only large enough for insertion of drainage tubes or to allow injected saline to escape through the wound. Larger incisions anywhere posterior to the tourniquet may serve for approaching different organs or drawing the intestine outside the abdomen. The intestine can thus be freely exposed for operative purposes upon a rubber sheet or in a shallow pan, and can be kept chilled by a jet of iced saline or by Therm-O-Rite applicators.* Under any of these conditions the tourniquet, applied before the incision is made, compresses the abdominal walls to form an effective barrier between the warm and cold parts of the abdomen. A different procedure may begin with a transverse incision; the intestine or other selected organs may then be isolated by ligation with light rubber bands, and the usual heavy tube tourniquet may be carried around the back internally and externally. The upper part of the abdomen can then be walled off with waterproof packing, the hind parts placed on ice or a refrigerated surface, the hind legs covered with ice and the peritoneal cavity chilled by irrigation with iced saline. Although, as already mentioned, it is possible to injure the intestine by too tight or too prolonged tourniquet pressure, thus far no ground for apprehension has been found concerning damage to the aorta or vena cava by the methods described. With any of the open methods, the cold saline irrigation can readily reduce the rectal temperature to 40°F. or 5°C. within one-half to one hour. This method, therefore, provides the most effective chilling that is possible for the trunk.

Another variant consists in chilling the intestine alone, while the body is kept warm. Spreading out the ligated intestine upon a chilled surface or in a pan of cold saline is the method required for practical operations. The commonest experimental plan, however, has been to have the animal lying prone, with the intestine immersed in a jar of iced saline under the belly, while the back is covered warmly and the fore and hind quarters rest on warm surfaces. In the preparation, the abdominal incision is only 2 or 3 cm. long; the small intestine is extruded as completely as possible while the large intestine is usually left inside. Light rubber ligatures have appeared preferable to clamps. The iced saline rises barely above the level of the ligature with the least possible wetting of the belly.

* Apparatus was furnished by courtesy of the Therm-O-Rite Products Company, Buffalo, N. Y.

The results will be summarized according to the above mentioned types of experiments.

PELVIC LIGATIONS

A tourniquet just above the pelvic bones may conceivably be needed for hemorrhage, shock or infection below that level. With lesions of the thighs or hips the body cavity may remain closed, but it must be opened for internal hemorrhage or involvement of the pelvic organs.

Besides the fatal shock in rats from application of such a tourniquet for one and one-half to two hours at room temperature,[4] the males die with even shorter periods, such as one-half to one hour, from urinary obstruction and hydronephrosis, while the females survive after a period of dribbling of urine. Paraplegia is severe and temporary; disturbances of defecation slight and temporary. The spinal cord has protection against tourniquet pressure and supposedly retains adequate circulation. That the paraplegia is due to asphyxial degeneration of peripheral nerves seems to be confirmed by its temporary character.

All the above injuries in rats were reduced by refrigeration and the same rules apply in cats and dogs, with some differences of time and details. No tests at room temperature were made in cats. In one cat the tourniquet was applied for two and one-half hours with external icing and no saline injections, so that at the end the rectal temperature had fallen only to 54°F. or 12°C. There was an easy recovery with only slight and transitory weakness of the hind legs. Incisions to permit irrigation of the pelvis with iced saline did not improve the results, as one cat recovered with transitory partial paralysis after a three-hour ligation while another died in forty-eight hours after a two and one-half-hour experiment. In general the increased efficiency of refrigeration seems to be more than counterbalanced by the special sensitiveness of the peritoneum in cats.

In one dog, a tourniquet above the pelvis for one hour at room temperature resulted in severe paraplegia which cleared up almost completely in three weeks. In another dog a three-hour ligation was followed by complete paraplegia which has persisted without important improvement for two months. Regeneration of nerves will presumably require longer time in the dog than in the rat, and the later result or autopsy must show whether the spinal cord was involved.* The degree of shock was not dangerous, and especially in view of the prominent factor of paraplegia it seemed unprofitable to go on to learn the time limit required for actual death.

In similar experiments, the external application of ice decidedly reduced all forms of injury, and injections of iced saline without surgical incision improved the results further. In this way ligations above the pelvis for one to three hours occasioned only slight disturbances. The longest tourniquet application was for six and one-fourth hours; the dog recovered easily but had very marked weakness of the hind legs which passed off almost completely in three weeks. Though this was evidently not the maximum endurable time limit, it seemed sufficient and no longer experiments were undertaken.

A few experiments of two to three hours were performed with incisions exposing the pelvis more or less widely for examination and saline irrigation. The results were broadly similar to the preceding though exact comparisons were not made. The main point was that the best possible refrigeration did not abolish all injury. The prostration, even if brief and slight, could probably be interpreted as true shock, though no tests concerning its nature were performed. Also some degree of weakness of the hind legs was never

* After three months of practically unchanged paralysis the dog was killed for autopsy. Cursory microscopic examinations revealed no obvious changes in the spinal cord or sciatic nerves. Evidently, therefore, the intraspinal blood supply is sufficient to prevent any gross degenerations during three hours without refrigeration. It remains for special staining and study to determine whether any fine changes in the nervous tissue can be found or whether the persistent paraplegia must be classed as functional.

entirely preventable. Both the local and the general weakness were increased either by lengthening the individual experiment or by repeating the ligation at intervals of a few days in the same animal. In cats and dogs, the disturbances of urination and defecation were always slight, even with ligations at room temperature. Temporary diarrhea was usual and in the severest experiments it might be mixed with blood.

Man is more susceptible than the dog and cat to edema and perhaps also to nerve injury; therefore, abdominal ligation may perhaps cause temporary disturbances of urination in the form of either bladder paralysis or prostatic swelling, along with more or less paresis of the legs. The main lessons of the dog experiments, however, seem to be: first, that the general injury from pelvic ligations and refrigeration in normal animals is so slight that the procedure may be considered feasible when necessary in weak or shocked human patients; second, that the pelvic organs tolerate refrigeration excellently and that no permanent damage to them need be feared at least with ligation periods up to six hours.

REFRIGERATION OF ISOLATED INTESTINE

Previous experiments[5] showed that the chilled intestine can remain viable for long periods without circulation. For example, a small loop was thus preserved for sixteen hours with no indication that this represented the utmost time limit. During refrigeration the intestine retains firm texture and approximately normal color. After restoration of circulation it flushes a clear pink and is strikingly healthy in appearance without any suggestion of necrosis.

Notwithstanding this excellent preservation of tissue, refrigeration of the whole or any large portion of the small intestine proved fatal in cats. That this was not due to specific functional disturbances in the upper bowel or feces or bacteria in the lower bowel was proved by the equally fatal result when either the upper half or the lower half of the bowel length was refrigerated. The condition was evidently not mere shock, and the severe secondary type of anemia developing in the rare animals which lived as long as a week suggested the possibility of a functional disturbance in the liver resulting from the chilling. The present experiments, limited to five cats, confirmed the occurrence of death within twenty-four to forty-eight hours after refrigeration of the small intestine for periods as short as one-half to one hour. Fasting for two or three days before the experiment did not save the animals. In one instance the intestine was warmed with warm saline immediately before and after removal of the ligature; this animal lived three days to die of peritonitis, but there was no further trial of this kind in cats.

It was unfortunate that circumstances limited the previously published experiments to small animals, because they tended to confirm prevalent preconceptions concerning the danger of chilling any peritoneal organs. The opportunity to use dogs immediately disproved the greater part of these fears regarding the intestine. After occasional early fatalities from flaws of technic, it soon became evident that efficient chilling allows dogs to survive two or three hours of ligation of the entire free portion of the intestine and to appear as well the next day as after a simple laparotomy. With practice the time has recently been extended to five hours, and it is not known whether this limit is uniformly safe or whether it can be extended still further by better technic.

These are the results obtained with the dog in the prone position and the intestine hanging down into a jar of iced saline, involving no trauma during refrigeration beyond the slight stirring needed occasionally to assure penetration of cold among the intestinal coils. Although a statistical comparison is lacking, there have been poorer results with the animal supine in the usual operative position and the intestine drawn out on a cold surface or in a pan of

cold saline. Fatal accidents have been more numerous, prostration greater and the safe period apparently limited to two or three hours. These difficulties are perhaps largely explainable by less thorough chilling and avoidable by better technic. It is necessary also to consider two factors which may set definite limits to intestinal refrigeration:

1. *Enteritis.* The beautiful rosy flush of the intestine after release of the ligature passes on into a reactive inflammation. This seems to be a direct consequence of the low temperature, even when the bowel has not apparently suffered from anoxia. It becomes more severe with increased duration of the refrigeration and is not preventable by any means yet known. There is also an influence upon the portion of the bowel not ligated, because some diarrhea usually begins during the ligation and in long experiments is mixed with blood. While shock may be admitted as a temporary factor, the dominant element of enteritis is established by examination of the bowel and by the continuance of diarrhea or melena for several days or, in severe cases, weeks. The intestine is typically smooth, shining gray on its peritoneal surface and deep dark red with congestion and hemorrhage in its mucosa. A discharge of blood and mucus may mix with the intestinal contents, or sometimes there may be light brown fluid in the lumen while a fibrinous bloody exudate clings to the wall. The feces may present various appearances of bloody diarrhea, or sometimes take the form of granular masses of blood and fibrin closely resembling sausage. Doubtless connected with this enteritis is the sometimes striking anorexia. An extreme example was a dog which wagged his tail cheerfully, ran around with fair liveliness, and showed no symptoms except slight weakness, diminishing diarrhea and complete refusal of food for nearly three weeks, after which he recovered completely.

2. *Shock.* There are plain indications that the chilled intestine is not immune to injury and shock. Actual intestinal operations have not been included in these experiments, but the intestine has been spread out and handled more or less roughly for various periods to imitate examination and test the influence of trauma. This extra handling is believed to account partly for the poorer resistance of animals experimented upon in the supine as compared with the prone position. Reflection shows that this result is not out of harmony with the absence of shock in operations on refrigerated limbs. During ligation and refrigeration, no trauma to limb or intestine produces any constitutional effect. If damaged tissues are left in a limb after operation, the absorption of their products causes the usual shock effects. The intestine is composed of softer and more vulnerable tissue than a limb, and handling or other trauma leaves minute lesions. Such lesions distributed throughout the length of the intestine can produce a large shock effect. Refrigeration seems nevertheless to increase the resistance of the intestine to trauma and shock, and this result may be explained theoretically both by the suspended animation due to low temperature and by the firmer consistency.

The harmful effects have been described with emphasis upon their most extreme manifestations under the severest tests. The main information from the experiments, however, is that the entire free portion of the intestine can be kept outside the body at a temperature near freezing during the length of time required for any ordinary operation, with practical safety as regards local and general consequences.

HIGH ABDOMINAL LIGATIONS

The placing of a tourniquet close under the rib margin is the most formidable undertaking in this series, because it includes stoppage of circulation in an increased mass of trunk tissues and the intestine simultaneously.

Accordingly, the time limits are shorter than with the procedures previously described. As an exception, one cat recovered

after such a ligation for one and one-fourth hours, but others have died from shock or cachexia after experiments of only one hour. The longest refrigeration with closed abdomen from which dogs have permanently recovered has been three hours. This period can probably be extended by better technic but an absolute limit is probably set by two factors: First, with the blind application of an external tourniquet there is always the chance of pinching the intestine in such a way that a strangulated loop projects into the warm part of the abdomen above the tourniquet, and as long as there is the possibility of such an accident the ligation period cannot safely be extended beyond the survival limit of such an isolated loop. For example, in one dog which died after a high ligation of 4½ hours nearly the whole intestine, large and small, showed only the usual inflammatory reaction, but a small segment of the transverse colon was necrotic from strangulation where it had been shut off from both blood supply and refrigeration. Second, this procedure is followed by all the symptoms previously described, notably enteritis and shock. Thus, one dog subjected to high abdominal ligation for five hours died within ten hours, with profuse bloody diarrhea and the typical appearance of shock. There is ample reason for shock in the large mass of asphyxiated tissue and the imperfect refrigeration.

In comparison with these experiments with closed abdomen, the surgical opening of the abdomen offers two apparent advantages, namely, the more accurate placing of the tourniquet to avoid accidents and the more rapid and efficient chilling. Nevertheless, the actual results thus far have been inferior to those with a closed abdomen, the prostration being greater, the mortality higher and the maximum time limit with complete recovery only two and one-fourth hours. The effects are slightest when the abdomen is merely opened and the intestine left undisturbed except for the cold saline irrigation, and with further attempts along this line the above stated results could probably have been bettered. The great majority of the experiments included spreading out the intestine and handling it crudely during the refrigeration and the injury thus produced evidently more than counterbalanced the more thorough chilling.

These findings show that the drastic chilling of nearly one-half of the total body mass, including almost the entire intestine, is a radical procedure involving shock and other injuries. Formal tests to prove the reduction of shock by refrigeration were omitted as superfluous. Two facts deserve practical attention: First, simple inspection of the intestine, and also the far slighter paraplegia, furnish a sufficient demonstration that, in any case in which complete stoppage of the abdominal circulation by tourniquet or otherwise is found necessary, the danger and harm can be diminished by reduced temperature. Second, the ability to spread out the entire free intestine outside the abdomen, and the comparatively slight disturbance resulting from refrigeration of the entire lower part of the body for limited periods such as one hour, may have possible usefulness for operative purposes in certain desperate cases, especially if the technic is further developed.*

* More recently, it has been attempted to use rabbits for tests of the practical application. Fatal degrees of shock were produced by either (*a*) dipping the hindquarters of the anesthetized animals in boiling water for a definite time, such as thirty seconds, or (*b*) placing tourniquets on both hind legs for seven or eight hours. An extreme illustration of primary shock was found in the experience that lightly anesthetized rabbits often react to an extensive brief burn by a convulsive reflex jerk and death within a few seconds. Treatment of secondary shock was attempted by applying an abdominal tourniquet, refrigerating the hind parts, and finally amputating the hind legs. Except for holding symptoms in abeyance while the tourniquet was in place, the outcome was failure, since deaths were more numerous or earlier among the animals operated upon than among those untreated. As regards the practical interpretation, it is recognized that an abdominal tourniquet causes some shock under any conditions; it can only be useful if it permits doing something important enough to be worth the temporary added injury; the rabbit is apparently too delicate to furnish a reliable criterion of human resistance; and nothing invalidates the main fact that if an abdominal tourniquet is to be used, all the harmful effects of it are reduced by lowered temperature.

MISCELLANEOUS OBSERVATIONS

1. *Upper Abdominal Organs.* Although it might be physiologically interesting to exclude the liver from the bodily economy for a number of hours and then restore it unharmed, such an attempt seems theoretically unpromising. The entire dangerous region of the upper abdomen and the vital organs contained in it are outside the grasp of the tourniquet placed below the rib margin. An experiment including this region was performed upon one dog. Through a curved incision below the rib border, a tourniquet of light rubber bands was placed above the liver, and behind it a heavy tourniquet was carried around the back. With all circulation below the diaphragm thus blocked, while the head and thorax were warmed, the lower part of the body was iced as usual and the entire peritoneum flooded with a current of cold saline. Feeble heart action and slow respiration continued for twenty minutes and then ceased. The tourniquets were quickly removed and refrigeration stopped. Artificial respiration soon restored the pulse but it was ten minutes before spontaneous breathing returned. Excellent heart action and respiration then continued for one-half hour, but after the incision was closed and the danger seemed past the animal suddenly died and gave no response to artificial respiration.

Regardless of the feasibility of chilling individual organs such as the kidneys,[6] stomach or spleen, there appears to be no prospect of safe refrigeration of the liver or of the upper abdomen in general. The rib margin appears to be the highest practicable level of ligation for this purpose. Even in the experiments with intestinal refrigeration, the harmful or fatal effects have apparently been less when the incision was made in the middle or lower abdomen rather than near the ribs where some chilling might be transmitted to the liver and adjacent organs.

2. *Optimum Refrigerating Temperature.* Many incidental observations leave no doubt that local and constitutional dangers are increased in proportion as the temperature is raised above freezing, or at least above 5°C. The intestine furnishes excellent opportunities for tests. No lesions suggestive of frostbite or harmful effects of any kind have been noticed with any temperatures short of actual freezing. One formal comparison was made with refrigeration of the isolated intestine for four hours within a range of 1° to 5°C. in one dog and 15° to 20°C. in another dog simultaneously. In the former case the intestine showed good color throughout the ligation and a prompt bright flush on release, and the dog easily recovered. In the latter animal the ligated intestine developed a deep blue color, the change to pink required a couple of minutes after release, and acute death followed evidently from shock. At the same time it is clear that a reduction even around 20°C. or 70°F. greatly reduces local and constitutional injury as compared with normal body temperature. There is also an interesting picture of the mesenteric veins which are full of blood but remain unclotted practically indefinitely at a sufficiently low temperature. The time required for intravascular thrombosis might serve as a measure of the efficiency of tissue preservation at different temperatures, though the level of 20°C. still suffices to prevent this process for at least five hours.

3. *Refrigeration without Tourniquet.* One rather weak dog was placed in the prone position, with the entire free intestine hanging down into iced saline and with the rest of the body well warmed, in exact reproduction of the standard procedure except that the ligature on the intestine was omitted. Strong pulsations in the mesenteric arteries made visible fluctuation of the saline solution, but in only five minutes the dog died quietly, when the rectal and esophageal temperatures had fallen only to 96°F. Even if a stronger animal might have survived a little longer, the result substantiates the traditional apprehension of surgeons concerning peritoneal chilling, and illustrates the indispensability of the tourniquet not only for

maintaining sufficiently low local temperatures but also for saving life. The reason for the early death, whether chilling of the liver, nervous reflex, or anything else was not investigated.

4. *Temperatures after Tourniquet Release.* During refrigeration of any part, the general bodily temperature has sometimes been kept normal and sometimes has fallen to 90°F. or even lower. Upon release of the tourniquet the cold and wet parts have customarily been dried and warmed to variable degrees. In proportion to the extent of the refrigerated area, there is a fall of general body temperature after release, sometimes to 80°F. or lower, with accompanying symptoms. If the animal has been almost at the point of waking up, the fall of temperature following release of an abdominal tourniquet is likely to cause a lapse into total unconsciousness. There is danger in allowing too low temperature or too deep unconsciousness just before release because death may result. It is only remarkable that the pouring of warm blood into ice-cold regions and the return of chilled blood to the heart and other organs are as a rule so easily and safely tolerated, especially when the cold part may approximate one-half of the total body mass and the chilled portal blood must cool the liver sometimes for several hours.

The numerous but scattered observations have not afforded a precise conclusion concerning the central question of treatment at this stage, namely whether the tissues should be allowed to recover normal temperature gradually, and to what extent rapid artificial warming is beneficial or harmful. Obviously, the temperature must become normal within a reasonable number of hours, since "cold and exposure" stands as a recognized medical cause of death. On one hand it is easy to confirm Temple Fay's observations on artificial hibernation, in that dogs may remain unconscious with extremely low temperatures for six hours or more and still appear surprisingly well the next day. On the other hand there is agreement with Blalock's[7] decision that no degree and no duration of reduced temperature saves an animal from death in shock. Empirically, it has finally seemed best to warm the animal promptly and carefully but not to try to force the temperature immediately up to full normal level. The difference seems to be not a major one as regards the peripheral tissues because it is doubtful if any animal has actually died or been saved through changes of general temperature within the limits in question. The difference in regard to the intestine may be more important. The above described observations in paragraphs two and three have seemed to create a rather sharp distinction, namely, that the optimum temperature during ligation is as near to freezing as possible, and the optimum temperature without ligation is as near to normal as possible. Therefore, it has been the preferred procedure recently to begin flushing the intestine with warm saline, so as to raise its temperature somewhat for perhaps one minute before release and to continue this flushing so as to assist in the quick recovery of normal temperature after release of the ligature. According to the present impression, this plan is somewhat beneficial.

5. *Osmotic Influences.* One of the most prominent occurrences after prolonged intestinal refrigeration is a profuse blood-stained exudation. A forerunner of it may be seen in the pink staining of the saline solution during refrigeration, often with visible red corpuscles and small fibrin shreds. It is necessary to estimate the importance of either osmotic injury of permeability or diffusion of vital elements out of the tissues during refrigeration in the quest for needed improvement of technic. Comparisons have shown that the intestine can survive immersion in plain ice water for considerable periods, but the resulting inflammation is severe and in prolonged experiments may be fatal. Neither physiological saline nor Ringer solution prevents these results altogether. The importance of the colloid factor was shown by two experiments with saline-gum arabic solution as

marketed for transfusion purposes. In these two instances there was a practically complete prevention of the bloody exudation both during and after refrigeration. Therefore, in this respect either the gum solution or actual plasma may be considered the ideal medium. Nevertheless, from a practical standpoint this appears to be a minor consideration. The peritoneal exudation is unconnected with the more serious enteritis which is manifested in the bloody diarrhea, and this latter is not greatly affected by the use of either Ringer or gum-saline solution. In the laboratory accurate conclusions require exact conditions, and these are provided by one of the above mentioned media in a container which is either set in a freezing mixture of salt and ice or more uniformly chilled by metal tubes connected with a Therm-O-Rite apparatus. But it must always be remembered that wounds of the desperate nature envisaged in this investigation must usually be treated under emergency conditions, and a method requiring laboratory precision could have only limited practical usefulness. Therefore, an opposite set of conditions is presented by saline solutions made up crudely with a flat teaspoonful of table salt per pint of mixed tap water and ice, all chance of isotonicity being spoiled by the melting of the ice. All the results heretofore described are obtainable with a makeshift mixture of this kind. In fact, an added feature of the comparative experiment described in paragraph two was that the test at higher temperature was made with carefully prepared gum-saline solution, while the one at lower temperature was made by guess as just described. The general conclusion on this point is that while the best possible osmotic adjustment is desirable, it is of trivial importance in comparison with efficient temperature reduction, and that satisfactory practical results are obtainable with salt solution of crudely approximate composition.

6. *Intestinal Perforation.* Occasional deaths have occurred from intestinal perforation several days after the experiment, when shock was over and the animal appeared to be in good condition. These deaths become more numerous as the duration of refrigeration is increased. The uniform autopsy finding is that nearly all of the intestine is perfectly preserved. The peritoneal surface is gray, smooth and glistening. The bowel lumen contains brownish liquid, and after sufficiently severe experiments the congested mucosa and bloody exudate are as previously described. The bowel wall is firm and contracted but never spastically so as to cause obstruction, and it has a characteristic turgid consistency. Along the extensive, well preserved coils may be seen a few small ulcerated areas, some amounting to nothing more than an abrasion of the serous surface, others exposing the muscular layers to different depths, and one or possibly two containing a perforation 1 to 5 mm. in diameter. The known danger spots of pressure by clamps or tourniquet, or pinching of the intestine between the body and the saline container, can be recognized, but the ulcers described are at other places. They have seemed to be identifiable as the result of direct contact of the bowel with ice. The combined thermal, pressure and osmotic effects, also the possible cutting by sharp edges, can be safely tolerated for a time, so that perforation is rare with refrigeration of one to two hours but becomes more frequent after periods of four or five hours. This is, therefore, one of the forms of trauma requiring precautions.

7. *Infection.* The desirability of asepsis is too obvious for comment, but industrial and military wounds of the kinds here under consideration commonly involve the grossest contamination of the peritoneum with foreign dirt or the contents of ruptured intestines. When, as in the present experiments, all the manipulations are carried out by a single individual, there is difficulty in maintaining asepsis. Accordingly, for this reason and for imitation of the most primitive clinical conditions, all the above described experiments were per-

formed without any aseptic care, aside from shaving of the immediate wound area. There was no preparation of hands or instruments. The intestine was spread out on nonsterile surfaces or in saline with ice containing visible specks of dirt, and sometimes was unintentionally or intentionally smeared with loose hairs or other foreign matter. When any such material is shut up in the peritoneum, fatal peritonitis always results; but if it is washed off with cold salt solution which is filtered but not sterilized, there is usually no harm beyond the slight trauma involved in the washing. The final brief flushing with warm saline, as described in paragraph four, does not reduce the safety because the peritoneal adhesiveness is not immediately restored. To gain an impression of the transformation created by refrigeration, it is well for the orthodox surgeon to convince himself by trial that he can operate in this manner and seldom encounter peritonitis. The reason may be conceived as largely mechanical. The chilled peritoneum immediately loses all its characteristic adhesiveness. In this state it offers a glassy smooth surface, and contrary to traditional surgical teaching, both the visceral and the parietal peritoneum can be washed clean. Tests of absorption would be of interest, because they might show changes away from specific protoplasmic absorption in the direction of freer nonvital diffusion; but at present it may be assumed that chemotaxis and penetration by bacteria are totally inhibited. Granting cleanliness to the extent of absence of solid foreign particles, the normal resistance of the peritoneum perhaps suffices to dispose of any remaining bacteria. There is a conceivable possibility of further hypotheses as, for example, that the bacteria quiescent from cold may be phagocyted in the returning rush of warm blood before they can recover their defensive mechanisms; but any such speculations must find support in the remarkable subsidence of infection in refrigerated limbs rather than in anything thus far demonstrated in the peritoneum. The incidence of peritonitis seems to increase with the duration of refrigeration, and this fact strengthens the suspicion that these infections begin in the areas injured by ice or other trauma rather than in the intact portions. It is questionable if the dog's peritoneum has any higher resistance than the human. The experiments without asepsis appear to warrant two principal deductions: first, that tissue vitality and resistance to infection are at least not reduced by refrigeration; second, that some possible advantages are offered for certain desperate cases with gross contamination of the peritoneum.

8. *Adhesions and Peritoneal Reactions.* As previously noted,[5] peritoneal areas injured in the course of refrigeration finally form adhesions, usually slight in extent and density. The tendency to adhesion formation is inhibited not only during refrigeration but to some extent for several days afterward. The question is, therefore, open concerning possible usefulness in preventing troublesome adhesions in limited locations. During this same period, characterized by the contracted and turgid state of the bowel, there is another question of altered absorptive and reactive properties in the peritoneum. It may be significant that none of the peritonitis cases in this series showed a rectal temperature higher than 102°F. (a barely appreciable elevation over the dog's normal range), and as a rule the course of temperature was subnormal. This peculiarity seemed scarcely explainable by the type of infecting organisms, as it occurred also with intestinal perforation, or by excessive prostration, because the general strength and the survival period of three to six days were equal to the average for dogs with general peritonitis. Such a temperature curve may also accompany peritonitis in dogs without refrigeration; but if the febrile tendency is reduced by refrigeration, there has at least been no sign of benefit for saving the lives of the animals.

9. *Treatment.* A few observations indicated that abdominal ligation and refrigeration are more dangerous shortly after

eating. It is impossible that emergency human cases should be prepared by fasting a day or two in advance like the dogs, but on the other hand therapeutic means such as the stomach tube were not used for the animals. Other considerations of treatment pertain to shock and infection. The occurrence or prevention of an abundant bloody peritoneal exudate seemed to have no decisive influence on the state of shock such as might be expected under the physical theory. Several saline irrigations to wash out the fluid on the chance that it might contain tissue poisons causing shock were equally negative for support of the toxic theory. Saline infusions were the only treatments used for shock, in continuance of the previously expressed view[4] that hemorrhage and shock, though often connected, are primarily distinct, and that the need in the former is for a fluid which will remain in the vessels but in the latter is mostly for an abundance of fluid which can readily escape from the vessels.

No treatment was used for peritonitis beyond a few trials of refrigeration. Washing the peritoneum with iced saline, with or without a tourniquet, can clear away pus and induce a clear bright hyperemia, but instead of being beneficial it seems rather to hasten death. The value of Temple Fay's prolonged crymotherapy for local infections is not here in question because it is a different process. The only known value of the temporary extensive refrigeration here described is for cleansing and checking potential infections. The previously mentioned inhibition of adhesions may be detrimental under some conditions, by preventing walling off and localization of infection, but under other conditions it may offer remarkable opportunities for drainage and irrigation. In the limbs, the wound edges adhere almost as soon as the temperature is raised, but the adhesiveness of the peritoneum remains inhibited after warmth is restored even during several days. The conditions of tissue resistance, absorption, drainage, irrigation and local chemotherapy remain to be investigated with reference to the treatment either of ordinary peritoneal infections or of dangerously contaminated wounds after refrigeration.

PATHOLOGICAL OBSERVATIONS

All the pathological studies of the refrigerated intestine were made by Dr. W. E. Youland. The reports on all animals stated that on gross examination the bowel was white and markedly contracted; the three coats were clearly recognizable and intact except as otherwise mentioned.

Dog 1. A tourniquet was applied below the ribs for five hours, with the abdomen opened. Refrigeration with ice and iced saline produced rectal temperatures of 68°F. in one-half hour, 56°F. in one hour, 46°F. in one and one-half hours, 44°F. in two hours, 40°F. in three hours, and 38°F. at the end, with esophageal temperature 98°F. After removal of the tourniquet the temperatures in one-half hour were 80°F. rectal and 85°F. esophageal; in one hour 88°F. rectal and 94°F. esophageal; in two hours 95°F. rectal and 96°F. esophageal. Death occurred apparently from shock seventeen hours after removal of the tourniquet and the autopsy was performed within two hours. Grossly, the intestinal coils were gray, shining and turgid as usual. Dr. Youland's microscopic report was, in summary, as follows. It seems to agree with the interpretation of the origin of infection in damaged areas:

The specimen of small intestine appears structurally intact. The lumen is filled with cross sectioned glandular tissue so that no actual lumen is seen. The mucosa appears markedly thick and consists of closely packed long tubular glands separated by barely visible fibrocapillary tissue. Underlying them is a thin layer of loose fibrillar tissue containing a moderate number of mononuclear cells. The appearance of the epithelium and goblet cells indicates a "resting" stage of the mucosa.

The muscularis mucosae and outside of it the inner longitudinal and outer circular muscle layers are thick and contain numerous markedly dilated capillaries. The nervous structures appear normal.

The serosal endothelium shows hyaline thickening in some places. Otherwise it is generally normal.

Some sections show collections of apparently intact lymphoid tissue, free from discoverable cytological or cytonecrotic changes.

In one microscopic section the serosa shows a markedly thickened layer of hyaline material which, at the surface, stains poorly with eosin. There are numerous clumps of cocci upon the surface of, and imbedded in this hyaline material. The muscle tissue underlying this area shows marked atrophy of the fibers with a possible edema of the interspaces.

One microscopic area shows necrosis of the serosal endothelium. The remainder of the serosa in this section is intact.

Another section of the intestine shows rather extensive edema of the subserosal layer with fibrin formation, slight to moderate mononuclear cell infiltration, hyaline fraying of the serosa with here and there a clump of bacteria.

The attached mesentery shows numerous large and small blood vessels. These appear intact and normal throughout. There is no evidence of any thrombosis. The smaller capillaries show extreme dilatation and engorgement with red blood cells.

DOG 2. A high abdominal tourniquet (just below rib margin) was applied for three hours, while the soaped parts posterior to it were buried in ice. The esophageal temperature was kept at 96 to 98°F. throughout. After one hour the rectal temperature had fallen only to 74°F. Intraperitoneal injection of 300 cc. iced saline reduced it within ten minutes to 64°F. At the end of two hours it was 52°F., and after the third hour 50°F. The unconsciousness, already unduly deep, became profound after removal of the tourniquet, and the eye reflex remained absent during five hours of subsequent observation. At the end of this time the pulse was 66, respiration 20, esophageal temperature 88°F., rectal 86°F., with bloody diarrhea in progress. Seven hours later (twelve hours after release of tourniquet) the dog was found dead but quite warm, showing that death had been very recent and also that something like normal temperature had been regained.

In the various microscopic sections, the closely packed glands of the mucosa showed various degrees of mucous hypersecretion, also extreme congestion of capillaries at their tips. Otherwise all three coats were intact.

DOG 3. A transverse incision was made across the upper part of the abdomen. A tourniquet of light rubber bands was placed about the intestine, and behind it a heavy tourniquet was passed around the body. The posterior parts, including the peritoneum, were packed with ice and flooded with ice-water. There was no embarrassment of breathing, such as occurs with a tourniquet around the closed abdomen. The esophageal temperature was down to 90 to 92°F. during most of the time. Nevertheless the first part of the treatment was inefficient, so that the rectal temperature was reduced only to 72°F. in one hour. It was then rapidly lowered to 56°F., and was 50°F. at the end. The duration of ligation was two and one-fourth hours. With the usual external heat applications both esophageal and rectal temperatures rose slowly, and three hours after removal of tourniquets they were 94° and 84°F., respectively. Twelve hours later the dog was found dead and cold, with blood tinged fluid filling the abdomen. The intestine was mostly pale and firm as usual, but in some places was pink and slightly soft, presumably from direct contact with the ice. On section, a thick bloody exudate was found sticking close to the reddened mucosa.

The microscopic findings were extensive superficial autolysis of the mucous membrane, marked mucous hypersecretion of the remaining glands and intact muscular and serous coats.

DOG 4. The body was swathed in a sheet of rubber dam, which was sewn to the edges of the skin wound. Through the small incision in the upper portion of the abdomen the entire free portion of the intestine was extruded, ligated and immersed in isotonic gum arabic-saline solution for four and one-half hours. The rectal and esophageal temperatures were easily kept normal, but the chilling of the intestinal bath was inadequate. Ten hours after removal of the ligature the dog was found dead with no exudate in the peritoneum.

Microscopically, a slight superficial autolysis in some mucosal areas was interpreted as probably a postmortem digestion. There were a few points of trivial inflammation in the serous coat. Essentially, the findings were normal in all three coats.

CONCLUSIONS

Discarding cats as unsuitable, the following conclusions are based on experiments with dogs:

1. Refrigeration permits stoppage of circulation by a tourniquet or ligature in the region of the abdomen to be tolerated without fatal injury for considerable periods; for example, more than six hours with stoppage just above the pelvis, three hours with stoppage just below the rib margin and five hours with ligation of the entire free portion of the intestine alone. Large injections and irrigations of iced saline solution are a harmless and valuable aid in the refrigeration of such large tissue masses.

2. The entire condition and technic need to be further studied and developed, but at present the most important known considerations for safety are efficient chilling to the nearest possible point above freezing, avoidance of trauma, and minimal time of operation, while osmotic and aseptic niceties are secondary. Along with the excellent preservation of tissue vitality, probably the most striking feature is the small risk in operating without asepsis and the effective cleansing of the peritoneum by iced saline flushing.

3. The abdominal tourniquet being not unknown in surgery, the gist of this investigation is that low temperature greatly reduces local and constitutional injuries and dangers, the chief of which are shock, paraplegia and enteritis. These bad effects are not wholly prevented, and this radical method is not calculated to replace ordinary surgical usage under ordinary circumstances. It appears worthy of clinical trial in conditions and emergencies which are otherwise hopeless, for example, in the severest hemorrhage, burns and wounds of the lower part of the body. The procedure is most promising when limited to the hips and pelvis, reasonably hopeful if a damaged intestine can be refrigerated while the body remains warm, and most difficult if approximately half of the total body mass must be refrigerated along with the intestine. Granting a high mortality among these cases which are inoperable by any other method, such an experience especially in traumatic and military surgery can furnish a decisive evaluation of refrigeration in the abdomen.

REFERENCES

1. Allen, F. M. Local asphyxia and temperature changes in relation to gangrene and other surgical problems. *Tr. Ass. Am. Phys.*, 52: 189–194, 1937.

———. I. Surgery of limbs. Reduced temperatures in surgery. *Am. J. Surg.*, 52: 225–237, 1941.

Crossman, L. W., Ruggiero, W. F., Hurley, V. and Allen, F. M. Reduced temperatures in surgery. II. *Arch. Surg.* (to be published).

2. McElvenny, R. T. The effect of cooling traumatized and potentially infected limbs. *Surg., Gynec. & Obst.*, 73: 263–264, 1941.
3. Fay, T. Clinical report and evaluation of low temperature in treatment of cancer. (Also earlier papers.) *Proc. Internat. Assemb. Inter-State Post-Grad. M. A. North America*, 292–297, 1941.
4. Allen, F. M. Physical and toxic factors in shock. *Arch. Surg.*, 38: 155–180, 1939.
5. Allen, F. M. Ligation and refrigeration of intestine. *Surgery*, 3: 893–898, 1938.
6. Allen, F. M. The tourniquet and local asphyxia. *Am. J. Surg.*, 41: 192–200, 1938.
7. Blalock, A. and Mason, M. F. A comparison of the effects of heat and those of cold in the prevention and treatment of shock. *Arch. Surg.*, 42: 1054–1059, 1941.
8. Brooks, B. and Duncan, G. W. Effects of temperature on survival of anemic tissue. *Ann. Surg.*, 112: 130–137, 1940.
9. ———. Ibid. The influence of temperature on wounds, 114: 1069–1075, 1941.
10. Allen, F. M. Mechanical treatment of venomous bites and wounds. *South. M. J.*, 31: 1248–1253, 1938.

Observations on local measures in the treatment of snake bite. *Am. J. Tropical Med.*, 19: 393–404, 1939.

11. Ibid. Ligation and refrigeration of intestine. *Surgery*, 3: 893–898, 1938.
12. Ibid. Experiments concerning ligation and refrigeration in relation to local intoxication and infection. *Surg., Gynec. & Obst.*, 68: 1047–1051, 1939.

CLINICAL AND ANATOMICAL INVESTIGATIONS OF DEEP FASCIAL SPACE INFECTIONS OF THE HAND

J. EDWARD FLYNN, M.D.
Surgical Staff, Boston City Hospital
BOSTON, MASSACHUSETTS

INFECTIONS of the deep fascial spaces of the hand present a most serious surgical problem. An accurate knowledge of the fascial distribution of the hand is basic for the proper treatment of deep fascial space abscesses.

Some recent work is contradictory of the more universally accepted facts. Brickel[1] describes the palmar foyer and the adductor space. He describes the palmar foyer as a triangular-shaped cavity. The floor of the foyer is formed medially by the two medial volar interosseous muscles and fascia, and laterally by the adductor pollicis muscle with its fascia. The roof of the cavity is the palmar fascia whose marginal septum on the ulnar side blends with the fascia of the short muscles of the little finger and dips into the groove between them and the fifth flexor sheath. On the radial side, the edge of the palmar fascia blends with the fascia of the adductor muscle to form the radial wall of the first lumbrical canal. The proximal portion of the palmar foyer is a common cavity, enclosing the profundus and sublimis tendons with the radial and ulnar bursae and the origins of the lumbrical muscles.

Distally, toward the metacarpophalangeal joints, septa arise from the deep surface of the palmar fascia, and blend with the walls of the tendon sheaths, separating the tendons from the lumbrical muscles. Proximal to the terminations of the flexor tendon sheaths, these septa blend with the fascia of the interossei and fascia of adductor pollicis muscle for varying distances but never so far as the carpal tunnel. Between the carpal tunnel and the proximal end of the fibrous tendon sheaths, the concavity of the palm is a common space clear from side to side, so that it is possible to pass an instrument across the palmar floor under the flexor tendons. It cannot be done more distally in the palm because of septa from the palmar fascia. The apex of this triangular palmar foyer points into the carpal tunnel. The distal part of the cavity is occupied by the lumbrical canals, tendon retinacula, associated with the septa which pass from the deep aspect of the palmar fascia to the fascia and ligaments forming the floor of the palm.

Brickel states that he has never seen a septum of fascia running from the palmar fascia to the middle metacarpal bone. Brickel describes the adductor space as a fascial space in which the floor is formed by the adductor pollicis muscle. The roof is the fascia of the adductor pollicis muscle. The fascia proper of the adductor pollicis continues over the lateral edge of the muscle. The fascia of the adductor pollicis also forms part of the floor of the palmar foyer. However, the lateral part of the adductor pollicis muscle is separated from the palmar foyer. Brickel states that in all his dissections and injections he never found a special palmar septum, extending from beneath the flexor tendons to the middle metacarpal bone, dividing the palmar foyer in halves. Thus, he states it is justifiable to discard the concept of middle palmar space in favor of a broader interpretation of its boundaries, and to discard the term thenar space in favor of the term adductor space, anterior and posterior.

Kanavel[2] describes the mid palmar space and the thenar space. He states that the midpalmar space lies in the palm, is bounded on the radial side by the fascia attached to the middle metacarpal bone,

on the ulnar side by the hypothenar eminence, distally it extends to within a thumb's breadth of the web, and proximally to the base of the palm. It lies upon the fascia covering the interosseous muscles, and its superficial covering is formed by the flexor tendons and palmar fascia. It is in direct communication with the lumbrical canals between the little and ring and the ring and middle fingers. The thenar space lies on the radial side of the middle metacarpal bone upon the adductor pollicis muscle; superficial to it is the palmar fascia and flexor tendons of the index finger. On the radial side it approaches the surface between the metacarpal of the thumb and index finger. It is limited distally by the deep transverse fascia, one thumb's breadth proximal to the web, and proximally by the base of the palm. There is a definite fascial septum from beneath the flexor tendons of the midfinger with its deep surface fusing with the fibrous tissue overlying the middle metacarpal bone which separates the thenar space from the midpalmar space.

METHODS

Three methods were used in the investigation of the deep fascial spaces of the hand: (1) Clinical study of deep fascial space infections of the hand; (2) anatomical dissection of hands with especial consideration of the fascial distribution; (3) injection of radiopaque material into the fascial spaces and *x*-ray study.

1. *Clinical Study of Deep Fascial Space Infections.* One hundred cases of deep fascial space infections of the hand were studied at the Boston City Hospital. This study was of value in determining the localization and course of infection in the deep fascial spaces of the hand.

2. *Anatomical Dissection of Fascia of the Hand.* An accurate dissection of the fascia of the hand is considered the most important procedure in attempting to arrive at an understanding of the so-called fascial spaces. Fascial and aponeurotic strata of the hand, especially in their formation of important surgical spaces, have been inadequately or improperly described in textbooks or anatomical literature. I believe that some understanding of the entire fascial distribution of the hand will clarify our knowledge of the surgically important fascial spaces of the hand. The hands were obtained from the autopsy room, cadavers, and some specimens were obtained following surgical removal of the upper extremity.

3. *Injection of Radiopaque Material.* A mixture of two parts petrolatum, one part cotton seed oil, and one part bismuth subnitrate was injected into the deep fascial spaces by the open method, through the superior boundaries of the fascial spaces, to show comparative relationship of pus accumulations to metacarpal bones. Solutions containing red lead and a 65 per cent solution of barium sulfate in a mixture of acacia may also be used.

CLINICAL OBSERVATIONS

Material and Incidence. One hundred cases of deep fascial space infections of the hand were studied at the Boston City Hospital. These were the most recent cases encountered at the hospital.

Location	Cases	Right Hand	Left Hand
Thenar	70	43	27
Midpalmar	30	22	8

In this series the thenar space infections were found more than twice as frequently as midpalmar space infections. The right hand was involved more often with each infection, almost twice as often as the left, with thenar space abscess, and more than twice as often with midpalmar space abscesses.

Mortality. There was a 3 per cent mortality rate in this series. The causes of death were bronchopneumonia, septicemia and uncontrolled diabetes.

Localization. In this series there was a tendency for infection to remain localized in one space. In no case was a direct exten-

Etiology: Thenar Space Abscess
(70 cases)

Type of Cases	Instruments or Focus of Infection
27 puncture wounds	8 wooden splinters, 5 needles, 3 broken glass, 1 pointed broom handle, 1 lead pencil, one nail, 1 tin can, 1 key ring, 1 pointed scissors, 1 wire
13 tenosynovitis	8 index fingers, 3 thumbs, 2 midfingers
7 septic abrasions	Over the thenar space, on palm
6 septic blebs	Over the thenar space, on palm
4 cellulitis	2 over the thenar space, on palm, 2 from thumb
3 abscesses	2 subcuticular, palmar, one metastatic (bacteremia)
3 burns of palm	2 curling iron, 1 carton of matches
3 osteomyelitis	2 involved second metacarpophalangeal joint (human bites), 1 involved second and third metacarpal bones
2 septic lacerations	Over thenar space, on palm
1 septic callus	Over thenar space, on palm
1 lumbrical space	Index finger

Midpalmar Space Abscess
(30 cases)

Type of Cases	Instruments or Focus of Infection
8 lumbrical space abscesses.	8 involved lumbrical canal of ring finger
6 puncture wounds	3 wooden splinters, 1 tack, 1 pin, 1 steel wool
4 septic abrasions	Over midpalmar space, on palm
3 tenosynovitis	2 midfingers, 1 ring finger
3 septic blebs	Over midpalmar space, on palm
3 cellulitis	Over midpalmar space
2 osteomyelitis	1, the fourth metacarpophalangeal joint (human bite) 1, the third metacarpal (dorsal space abscess)
1 septic laceration	Involved web between third and fourth right fingers

sion to forearm found. In two of the one hundred cases, both spaces became eventually involved. In each of the two cases the midpalmar space infection was secondary to the thenar space infection and was the result of extensive necrosis.

Differential Diagnosis. Tenderness over the palmar aspect of the space involved is probably the most important sign. Swelling is of value. With midpalmar space abscess there is obliteration of the concavity of the palm and a slight bulge over the palm. With thenar space abscess there is usually a rapid increase in size of the thenar area. The tissues of the thenar area seem to balloon out from the radial longitudinal crease of the palm. There is usually great swelling over the dorsum of hand with both infections. Position of the fingers is of some value. The middle and ring fingers are flexed when the midpalmar space is involved. The index finger is usually flexed when the thenar space is involved. Temperature ranges from 100 to 104°F. with each infection.

Treatment. The thenar space is best drained by transverse incision over the dorsum of the thumb-index web, at the middle of a line drawn between the distal ends of the metacarpal bones of the thumb and index fingers with the thumb in a position of abduction. Two incisions have been used for midpalmar space abscesses. Preferably a transverse incision is made over the distal transverse crease or an incision parallel to this crease directly over the center of the palmar convexity. Digital blood vessels and nerves must be identified. The vertical incision in the web between ring and little fingers, or in the web between mid and ring fingers may be used when large abscesses are found in the third and fourth lumbrical spaces. However, this incision has been followed by contractures when unwisely placed, when carried too far proximally, or at times when the web is completely severed.

Clinical Deductions. Deep fascial space abscesses of the hand tend to remain localized. Rarely, a spread from one space to another is found when local barriers are destroyed by necrosis.

ANATOMICAL DISSECTION OF FASCIA OF THE HAND

One hundred hands were dissected. The drawings are accurate portrayals of anatomical details in one dissection, and not a composite based upon several different dissections. Photographs were taken to reproduce important details.

Skin and Superficial Fascia. Two incisions were made in the skin of the palm, one longitudinally and one transversely through the center of the palm. Each of

four flaps was dissected free. Beneath the skin of the palm there is a layer of fatty tissue. From the palmar aponeurosis septa pass to the skin. These septa are vertical except in the region of the proximal and distal transverse creases of the palm where the septa are transverse or oblique. These septa constitute the superficial palmar fascia. Their presence accounts for the lack of mobility of the palmar skin.

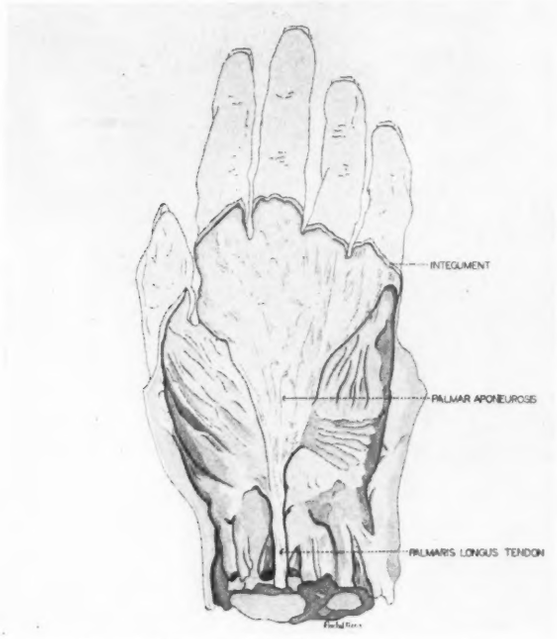


FIG. 1. Drawing of palmar aponeurosis.

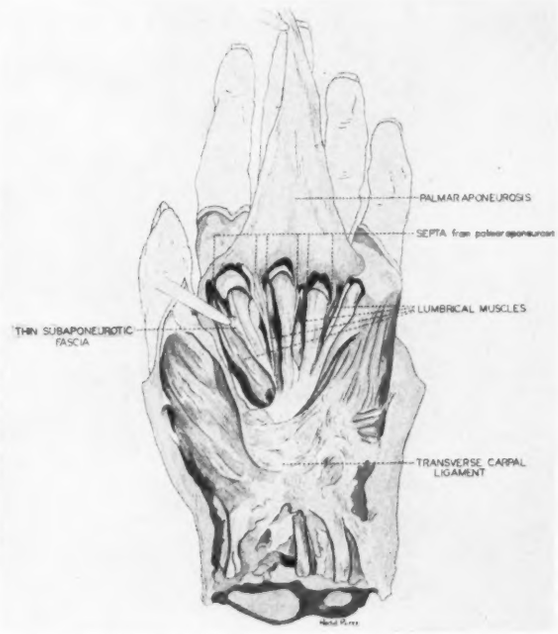


FIG. 2. Drawing of septa from palmar aponeurosis forming compartments for flexor tendons and lumbrical muscles.

Palmar Aponeurosis. The palmar aponeurosis invests the muscles and tendons of the palm. It consists of central, lateral and medial portions. (Fig. 1.) The central portion occupies the middle of the palm, is triangular in shape and of great strength and thickness. Its apex, deeply, is continuous with the distal margin of the transverse carpal ligament, and more superficially, receives the expanded tendon of the palmaris longus. Its base divides distally into four slips, one for each finger. Each slip gives off superficial fibers to the skin of the palm, and finger, those to the palm joining the skin at the furrow corresponding to the metacarpophalangeal articulations, and those to the fingers passing into the skin at the transverse fold at the bases of the fingers. The deep part of each slip subdivides into two processes which are inserted into the fibrous sheaths of the flexor tendons. From the sides of these processes offsets are attached to the transverse metacarpal ligament. At the points of division into slips, numerous strong fasciculi bind the separate processes together beneath the webs of the fingers. From the undersurface of the distal one-third of the palmar aponeurosis, septa are given off to fascia of interossei which separate the flexor tendons from the lumbrical muscles. The palmar aponeurosis gives off a septum on either side, which is continuous with the interosseous fascia, and separates the intermediate from the collateral group of muscles.

The lateral and medial portions of the palmar aponeurosis are thin fibrous layers which cover on the radial side the muscles of the little finger. They are continuous with the central portion, and with the fascia on the dorsum of the hand. The palmar aponeurosis may be considered as part of the fibrous investment of the entire hand, which in the midpalmar area is quite complicated. Superficial septa from the

superficial surface attach the palmar aponeurosis firmly to the superjacent skin. Septa arising from the deep aspect of the palmar aponeurosis serve to attach the aponeurosis firmly to the subjacent interosseous and adductor fascia. These septa divide the distal part of the midpalmar space into smaller compartments. The palmar aponeurosis beyond the hypothenar and thenar eminences is continuous with the fascia on the dorsum of the hand. Beneath the palmar aponeurosis is a thinner layer of fascia, which follows the internal aspect of the palmar aponeurosis but is not firmly attached to the heavier superjacent aponeurosis.

The Subaponeurotic Fascia. The subaponeurotic fascia is the thin fibrous tissue which lines the inner aspect of the palmar aponeurosis. It is this fascia which seems to be the source of the most confusion in investigations of the fascia of the hand. The palmar aponeurosis was cut from its origin with the palmaris longus tendon and transverse carpal ligament. The medial and lateral attachments were cut in the region of the hypothenar and thenar eminences. The palmar aponeurosis was then reflected and the longitudinal septa from the undersurface of the distal one-third of the palmar aponeurosis were incised. These septa divide the palmar cavity distally into channels for the flexor tendons and lumbrical muscles. (Fig. 2.)

The thin fascia lines the inner surface of the palmar aponeurosis throughout its course, and is distinct over the floor of the cavity as well as beneath the central portion of the palmar aponeurosis. Anteriorly or superficially, the thin fascia winds between and around the flexor tendons and holds them in a semifixed position. Laterally and medially, thin fascia is found internal to the projections of the palmar aponeurosis. The strong fibrous septa from the inner surface of the distal one-third of the palmar aponeurosis received an investment from the thin fascia as they form channels for the lumbrical muscles and flexor tendons. The floor of the midpalmar cavity is covered by thin fascia as it becomes the fascia for the interossei. As the thin fascia surrounds the flexor tendons, a

Fig. 3. The middle palmar septum coming from undersurface of flexor digitorum profundus of the midfinger to third metacarpal bone dividing palm into midpalmar and thenar spaces.

definite septum comes from beneath the flexor digitorum profundus tendon of the midfinger and is attached to the third metacarpal bone.

The Middle Palmar Septum. In all of the one hundred cases examined, a definite septum of thin fascia was found beneath the flexor digitorum profundus tendon of the midfinger. The septum arose from the thin fascia which interwound and surrounded the flexor tendons, and was attached to the periosteum of the third metacarpal bone throughout its entire length. This important surgical septum divides the palmar cavity into the midpalmar and thenar spaces. In all specimens examined, the septum extended proximally at least as far as the distal edge of the

transverse carpal ligament. In twenty-five of the one hundred cases, the septum extended one inch proximal to the distal edge of the transverse carpal ligament. (Fig. 3.)

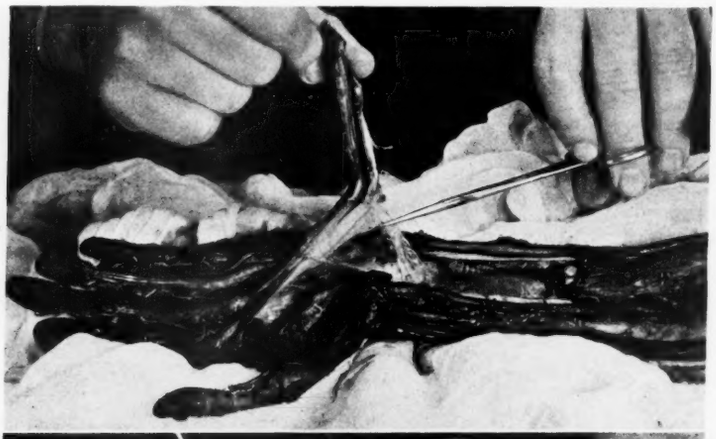


Fig. 5.

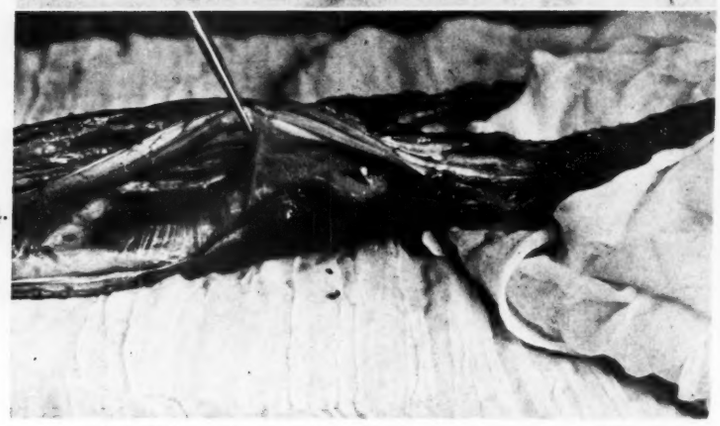


Fig. 4.

Fig. 4. The middle palmar septum as it forms lateral boundary of the midpalmar space.

Fig. 5. The middle palmar septum as it forms medial boundary and roof of the thenar space.

The middle palmar septum has a definite structure. As this septum leaves its attachment to the middle metacarpal bone it is one membrane. The distal one-half of the septum, usually about one-half way between attachments to flexor tendons and middle metacarpal bone, splits in a Y-shaped fashion. The medial arm of the "Y" continues toward the flexor tendons and ends beneath the third flexor tendons to complete the lateral boundary of the mid palmar space. (Fig. 4.) The lateral arm of the "Y" curves laterally, surrounds the flexor tendons of the index finger and then continues laterally, covering very loosely the adductor pollicis muscle. This thin lateral fascial arm then continues over the lateral edge of the adductor muscle and is attached to the posterior aspect of the adductor pollicis muscle about one-half way down the dorsum of the muscle. This lateral thin fascial arm may be called the fascia for the adductor muscle and forms the medial boundary and roof of the thenar space. (Fig. 5.) Proximally, the thenar space is bounded by a fold of the thin fascia which covers the adductor pollicis muscle. In none of the one hundred cases was there any communication between the midpalmar and thenar spaces. In no case could an instrument be carried across the palm beneath the flexor tendons without meeting obstruction by the middle palmar septum. (Fig. 6.)

Other Palmar Septa. Strong fibrous septa arise from the undersurface of the palmar aponeurosis and receive an invest-

ment from the subjacent, thin fibrous layer. These become attached to fascia covering the interosseous muscles and so form chan-

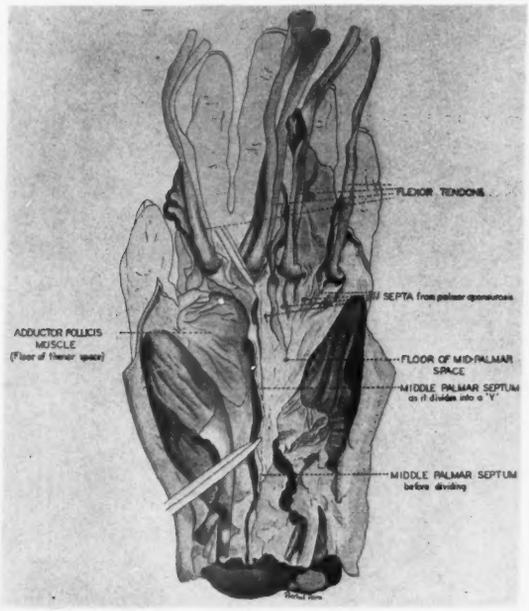

FLEXOR TENDONS
SEPTA from palmar aponeurosis
ADDUCTOR POLLICIS MUSCLE (Floor of thenar space)
FLOOR OF MID-PALMAR SPACE
MIDDLE PALMAR SEPTUM as it divides into a 'Y'
MIDDLE PALMAR SEPTUM before dividing

FIG. 6. Drawing of floor of midpalmar and thenar spaces. Septa are seen in distal one-half of midpalmar space. The middle palmar septum is seen as it divides in a Y-shaped fashion.

nels for the lumbrical muscles and flexor tendons. These septa extend no further proximal than the distal transverse palmar crease.

Fascia on Floor of Palmar Space. From the posterior aspect of the fascia of the interossei, septa are given off deeply which are attached to the metacarpal bones. The medial septum surrounds the third volar interosseous muscle and then becomes attached to the fifth metacarpal bone. The middle septum surrounds the second volar interosseous muscle and is attached to the fourth metacarpal bone. The lateral septum surrounds the first volar interosseous muscle and becomes attached to the second metacarpal bone. (Fig. 7.) The dorsal interosseous muscles are covered by fascia to form separate fascial compartments.

Dorsal Fascia. The palmar aponeurosis continues around the muscles of the thenar and hypothenar eminences and a slip is given off to the first and fifth metacarpal bones. The aponeurosis then continues over the dorsum of the hand, splits, ensheaths the extensor tendons and fuses between the extensor tendons.

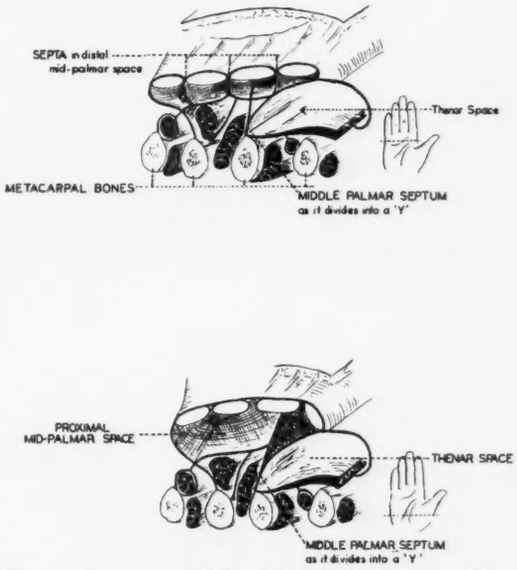

SEPTA in distal mid-palmar space
Thenar Space
METACARPAL BONES
MIDDLE PALMAR SEPTUM as it divides into a 'Y'
PROXIMAL MID-PALMAR SPACE
THENAR SPACE
MIDDLE PALMAR SEPTUM as it divides into a 'Y'

FIG. 7. Diagrams of fascial distribution found in cross sections through proximal one-third and distal one-third of the palm.

INJECTION OF RADIOPAQUE MATERIAL

A mixture of two parts petrolatum, one part cotton seed oil, and one part bismuth subnitrate was injected into the deep fascial spaces by the open method through the proximal boundaries of the fascial spaces. Roentgenograms were made to show a comparative relationship of pus accumulations to metacarpal bones. (Fig. 8.)

CONCLUSIONS

Anatomical dissection of the fascia of one hundred hands reveals that there is a definite midpalmar and thenar space. Infections of deep fascial spaces of the hand substantiated the concept of these spaces.

The midpalmar space extends from the middle metacarpal bone ulnarward to the radial side of the metacarpal bone of the little finger. Anteriorly, this space is bounded by the flexor tendons of the middle, ring and little fingers, the third and fourth lumbrical muscles and the thin fascia which connects these tendons and muscles. The posterior boundary or floor is formed by

the fascia, covering the second and third volar interosseous muscles, and the third, fourth and fifth metacarpal bones. In the distal one-third of the floor, small compartments are formed, as septa coming from the undersurface of the palmar aponeurosis are attached to the fascia of the volar interosseous muscles. These small compartments communicate with the midpalmar space. The medial boundary is the fascia on the radial side of the hypothenar muscles. The lateral boundary is the middle palmar septum which extends from the undersurface of the flexor digitorum profundus tendon of the midfinger to the middle metacarpal bone.

Distally, the midpalmar space extends to about 2 cm. proximally to the webs. The distal boundary is composed mainly of the fascial septa extending from the palmar aponeurosis to the floor of the space and some transverse fasciculi. The proximal boundary is a thin fascial septum usually found at about the level of the proximal end of the transverse carpal ligament. However, clinically, abscesses do not usually tend to enter the carpal tunnel. This fact is probably due to tissue response to infection, i.e., serous, cellular and fibrinous reactions.

The thenar space is bounded posteriorly by the adductor pollicis muscle. Medially, the boundary is the middle palmar septum,

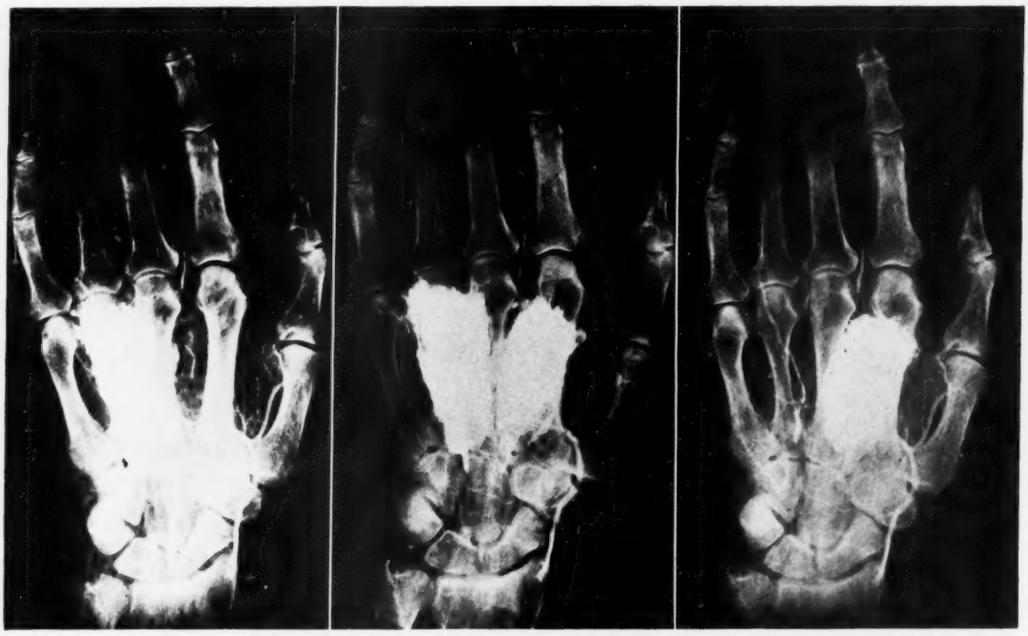


Fig. 8. *X*-rays of the midpalmar and thenar spaces filled with radiopaque material.

a thin fascia extending from beneath the flexor digitorum profundus tendon of the midfinger to the third metacarpal bone. Proximally, in all cases, thin fascia, which is a part of the adductor fascia, forms the boundary. This proximal boundary is found at about the level of the distal end of the transverse carpal ligament. The anterior boundary or roof is the thin layer of fascia, formed as the middle palmar septum splits and courses laterally. In its lateral course this thin fascia roof ensheaths the flexor tendons of the index finger to form part of the anterior boundary. The lateral boundary of the thenar space is formed by the thin fascia as it extends over the lateral edge of the adductor pollicis muscle and is attached to the dorsal aspect of this muscle. This distribution of fascia over the anterior, lateral and dorsal aspects of the adductor pollicis muscle clearly indicates why abscesses of the thenar space may extend to the posterior aspect of the muscle. However, the fact remains that abscesses of the thenar space tend to remain anterior to the adductor pollicis muscle.

REFERENCES

1. Brickel, A. C. J. Surgical Treatment of Hand and Forearm Infections. St. Louis, The C. V. Mosby Co.
2. Kanavel, A. B. Infections of the Hand. Philadelphia, Lea and Febiger.
3. Gray, H. Anatomy of the Human Body. Philadelphia, Lea and Febiger.
4. Collander, C. L. Surgical Anatomy. Philadelphia, W. B. Saunders.
5. Koch, S. L. Prevention and treatment of infections of the hand. *J. A. M. A.*, pp. 1365–1367, March 29, 1941.
6. Mason, M. L. and Allen, H. S. Indelible pencil injuries. *Ann. Surg.*, 113: 131–139, 1941.
7. Bellone, A. Osteoaponeurotic cavities of the palm, roentgen study to determine mode of propagation of suppurative processes. *Arch. di radiol.*, 15: 491–495, 1939.
8. Anson, B. J. and Ashley, F. L. Midpalmar compartment, associated spaces and limiting layers. *Anat. Rec.*, 78: 389–407, 1940.
9. Pemberton, P. A. Infection of fascial spaces of palm. *Am. J. Surg.*, 50: 512–515, 1940.
10. Spaulding, J. E. Fascial spaces of palm; surgical anatomy. *Guys Hosp. Rep.*, 88: 432–439, 1938.
11. Wilkie, D. Septic hand. *Brit. M. J.*, 2: 1127–1130, 1938.
12. Russell, E. P. Deep infections of hand. *J. Iowa M. Soc.*, 26: 689, 1936.
13. Toldt, C. Human Anatomy. New York City, Rebman Co.
14. Von Stapelmahr, S. Cavities of the hand from a surgical point of view. *Nord. med. tidskr.*, 10: 1341–1344, 1935.
15. Flack, F. L. Fascial space and bursal infections. *J. Oklaboma M. A.*, 27: 314–318, 1934.

Notice: The Lankenau Hospital, Philadelphia, Pennsylvania, is collecting material concerning Dr. John B. Deaver for a Memorial Collection in its library.

Photographs, letters, memorabilia, reviews, press comments, articles by or about Dr. Deaver will be greatly welcomed and appreciated. Photostatic copies can be made of material available for loan only. All communications should be addressed to the Library Committee, The Lankenau Hospital, Philadelphia, Pennsylvania.

ULTRAVIOLET IRRADIATION OF AUTOTRANSFUSED BLOOD IN THE TREATMENT OF POSTABORTIONAL SEPSIS

E. W. REBBECK, M.D.
General Surgeon, Shadyside Hospital
PITTSBURGH, PENNSYLVANIA

FROM July, 1938, through July, 1941, in the Shadyside Hospital, Pittsburgh, Pennsylvania, ultraviolet irradiation of autotransfused blood has been used as an adjunct to surgery in the treatment of postabortional sepsis. Seventeen patients were treated preoperatively and four postoperatively. Nine patients admitted instrumentation to produce abortion; two patients admitted taking medication. Eight abortions were apparently spontaneous. One patient with psychosis was treated after a therapeutic abortion because of apparent sepsis. One patient used medication and instrumentation. Ten patients were considered in a state of advanced infection on admission. Eleven were considered as early to moderately advanced infections, based on symptoms of fever, increased leukocyte counts, history of criminal abortions, toxemia, etc. The pathological conditions ranged from simple, uncomplicated, acute septic endometritis to acute salpingitis, bilateral, "frozen" pelvis, pelvic abscess and septicemia. Chemotherapy (sulfanilamide) was used in treating two patients; one patient receiving 530 gr. in five days; another (Case III) 135 gr. in thirty-six hours. In the first case it apparently was not helping the patient; and in the second case it was cancelled after irradiation as not needed.

One patient (Case X) was admitted with escherichia coli septicemia, the same organism being obtained from her uterus at operation. Three patients showed transient bacteriemia at operation. The patient in Case V at operation showed indifferent streptococci in the blood and uterus. The patient (Case XI) showed indifferent streptococci in the blood and Staphylococcus aureus in the uterus at operation. The patient (Case XII) showed pneumococci in the blood and uterus at operation, the organism was not specific in type. (It has been our experience in other pneumococcal infections that hemo-irradiation tends to act on the pneumococcus in some manner, making it unsuitable for typing.)

Cultures from the cervical canal, uterine cavity and including one cul-de-sac abscess showed:

Escherichia coli	3
Hemolytic streptococcus	2
Indifferent streptococcus	1
Staphylococcus	4
Diphtheroids	1
Pneumococcus	1
No growth	4
No cultures taken	7

(Two patients were readmitted.)

Whenever possible, our practice was to give preoperative blood irradiation and either immediately or the following day perform dilatation and curettage. In no case did we observe any spread of infection. When this therapy was used postoperatively in four patients with advanced infection, prompt relief of toxemia and decrease in fever was outstanding.

Blood irradiation therapy was given as follows:

19 days preoperatively	1
4 days preoperatively	2
1 day preoperatively	11
immediately before operation	4
2 days postoperatively	1
3 days postoperatively	2
4 days postoperatively	1

(One patient was readmitted.)

The four patients not treated preoperatively showed symptoms of temperature

rise and toxemia following surgery and were treated postoperatively because of apparent acute endometritis. It is noteworthy that no significant rises of temperature were observed even though the patients were treated at different intervals preoperatively. The results were essentially the same and strongly indicate the preventative value of hemo-irradiation.

CLINICAL OBSERVATIONS AND RATIONALE

This therapy consists in the administration of ultraviolet irradiation directly to the blood. By this method of application many of the important biophysical and biochemical effects produced by ultraviolet rays can be observed clinically. The reactions of special interest in this condition under discussion, which have a broad background in general medical literature, and which can be observed clinically are:

1. Attenuation and destruction of bacteria.[3,5,6,16]

2. Inactivation of toxins and viruses.[9,-11,15]

3. Increased absorption of oxygen by the blood.[8,10,12]

4. Increase in general resistance to infection.[4]

The work of the author in puerperal sepsis[14] and the papers by Hancock and Knott,[7] Barrett,[1,2] and Miley,[12,13] reporting the use of this method all emphasize these manifestations following such treatment. The results observed in patients following such treatment substantiates clinically that these and other reactions characteristic of ultraviolet spectral energy take place in hemo-irradiation.

The increase in general resistance following ultraviolet therapy has been thoroughly reviewed by Clark,[4] and is observed following hemo-irradiation. A significant fact is brought to notice in this series of cases in reviewing the charts and histories. None of the seventeen patients treated preoperatively had any untoward symptoms, following dilatation and curettage, as would be expected.

TECHNIC

The observable phenomena of systemic reaction to this form of treatment are consistent in a majority of cases. This is probably due to the fact that in the application of ultraviolet directly to the blood, using the Knott technic, a constant and exact control of all the variable dosage factors is maintained. Intensity of ultraviolet radiation, wave length, distance, time of exposure and volume of blood treated are all important factors that are controlled by this method.

The method of exposing venous blood directly to ultraviolet spectral energy and returning to the patient was evolved by E. K. Knott, of Seattle, Washington. This procedure became known as the "Knott Technic," and it was this method that Hancock and Knott, Barrett, Rebbeck, and Miley employed in the work they have reported.

The Knott technic consists in the withdrawing of a predetermined amount of blood from a patient and the exposure of this blood after citration to a selected band of wave lengths of ultraviolet rays and immediately returning it to the patient. This technic has been described in detail by Miley. It is essentially a surgical procedure. However, an apparatus has been designed that mechanically regulates all factors and through precise but simple operation makes the administration of this therapy a safe procedure.

Case 1. No. 75795. Mrs. K., age thirty-one, married, was admitted to the Shadyside Hospital November 2, 1938. She gave a history of her last menstrual period beginning October 18, and continuing until admission accompanied by moderately severe crampy pains in the lower portion of her abdomen. She denied any pregnancy or attempt at abortion. Her admission temperature was 102.2°F., pulse 120, respirations 24. An admission blood count was not done. Pelvic examination showed a large, tender, boggy mass posterior to the uterus with the cervix patent, uterus slightly enlarged and fixed anteriorly, adnexa not definable. She received

blood irradiation therapy preoperatively on the third admission day. A routine curettement plus incision and drainage of the cul-de-sac spontaneous abortion occurred, but the bleeding continued although slight in amount. About two hours prior to admission she

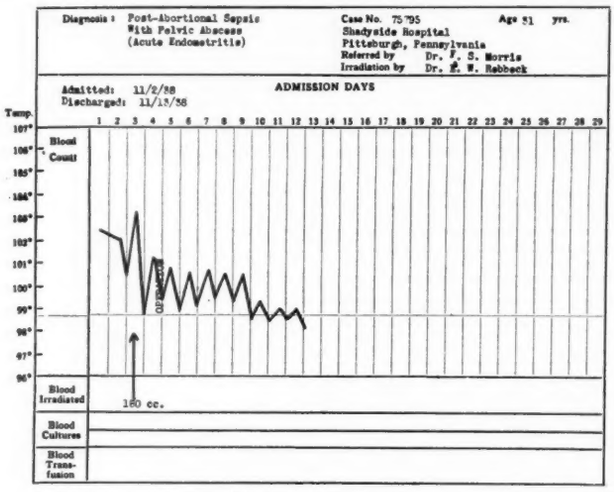


FIG. 1. Case I.

abscess was performed on the fourth day. As shown by the accompanying graph the temperature gradually receded. The patient made an uncomplicated recovery and was discharged in good condition on the eighth postoperative day. Examination of curettings showed acute endometritis with necrotizing placental tissue. Culture from the abscess showed staphylococcus. We believe this patient perforated the uterus in an attempt at abortion in spite of her denials.

developed severe crampy pains in the lower portion of her abdomen and severe vaginal bleeding. Her admission temperature was 98.6°F. pulse 104, and respirations 22; blood count was 3,030,000 red cells with 6 Gm. hemoglobin. A curettage was performed shortly after admission, and the products of conception, consisting of necrotizing placental tissue, removed. No uterine culture was taken. There was considerable bleeding at operation, and a count taken June 8, 1939, showed red cells 1,950,000, 5.8 Gm. hemoglobin, 6,100 white cells with 86 per cent neutrophiles (78 nonfilamented). At this stage her temperature showed a decided tendency to a septic course. She was moderately toxic and quite weak.

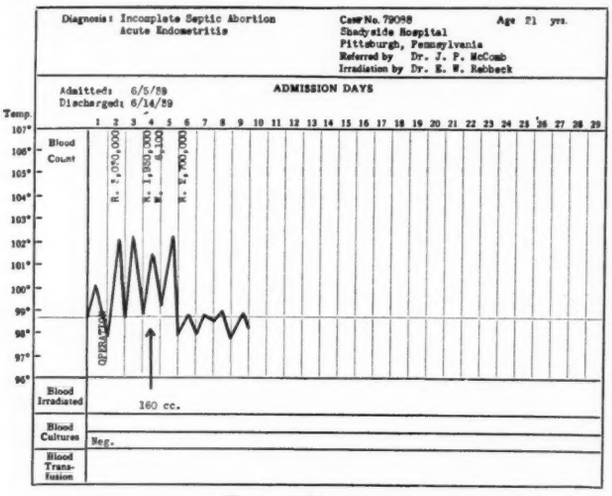


FIG. 2. Case II.

CASE II. No. 79088. Mrs. M., age twenty-one, was admitted June 5, 1939, with a history of bleeding for approximately three weeks. She was estimated two months pregnant at the time bleeding began. One week later a

Blood irradiation therapy was instituted on June 8. This was followed by a transient rise the next day then prompt recession to normal.

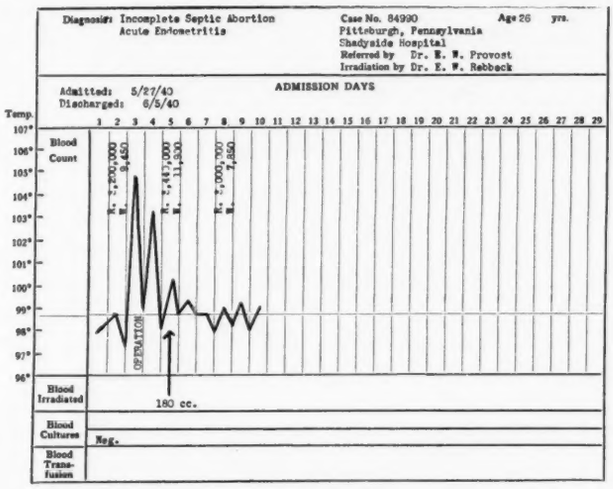


FIG. 3. Case III.

The patient felt decidedly better from the time she was irradiated. No bacterial growths were obtained from the blood. This fever was evidently sapremic in nature; however, the decided tendency to sepsis caused considerable concern. The patient was discharged on the ninth postoperative day in good condition. Her subsequent recovery was uneventful.

CASE III. No. 84990. Mrs. O., age twenty-six, para III, was admitted to the Shadyside Hospital on May 27, 1940, with a history of having fallen down steps at approximately the third month in her pregnancy and a spontaneous abortion ensued. This occurred six weeks prior to admission. She had slight to moderate amount of bleeding daily since the abortion occurred. She denied any attempt at self-induced abortion. Her admission temperature was 97.8°F. pulse 112, respirations 20. The day following admission her blood count showed red cells 3,200,000, hemoglobin 12.5 Gm., color index 1.2, leukocytes 9,450, neutrophiles 69 per cent (filament 29, nonfilament 40). A dilatation and curettage was performed on May 29. The pathological report showed necrotizing placental tissue. Approximately two hours after this surgical procedure she had a chill and her temperature rose to 104.8°F. with pulse 136, respirations 24. Sulfanilamide was immediately started, 140 gr. being given in the next thirty-six hours. During this time she had two more chills, her temperature ranging up to a peak of 103 degrees. By the morning of May 31, despite her temperature being normal, she was still moderately toxic. Blood count on May 31, showed 3,440,000 red cells, 10.2 Gm. hemoglobin, color index 1, leukocytes 11,900, neutrophiles 83 per cent (filament 31, nonfilament 52), sedimentation distance 79 mm. in one hour. Chiefly because of the moderate toxemia and septic blood count sulfanilamide therapy was discontinued on May 31, in favor of blood irradiation therapy, which was given the same day. Blood cultures taken May 30 and 31 were negative. No cultures were taken from the cervix or uterus. On June 1, the patient was markedly improved in all respects and continued to an uneventful recovery and discharge on June 5, 1940.

CASE IV. No. 88227. Mrs. C., age twenty-eight, married, was admitted to the Shadyside Hospital November 16, 1940. She had missed two menstrual periods and three weeks prior to admission began to have vaginal bleeding with moderate cramps. During this period she had two rather severe hemorrhages. The night prior to admission a severe hemorrhage with cramps occurred. The patient finally admitted that she had used a slippery elm stick six different times during these three weeks (she had inserted a slippery elm stick into her uterus six different times prior to admission). Her admission temperature was 99.2°F., pulse 100, respirations 20. Blood count showed 3,170,000 red cells, 10 Gm. hemoglobin, 3,350 leukocytes, 73 per cent neutrophiles (12 nonfilament, 61 filament). Urine showed considerable albumin, occa-

sional pus and blood. Culture from the cervix showed Staphylococcus aureus and hemolytic streptococcus. Blood culture November 22, shown by the accompanying graph temperature promptly receded, and the patient was discharged on the seventh postoperative day in

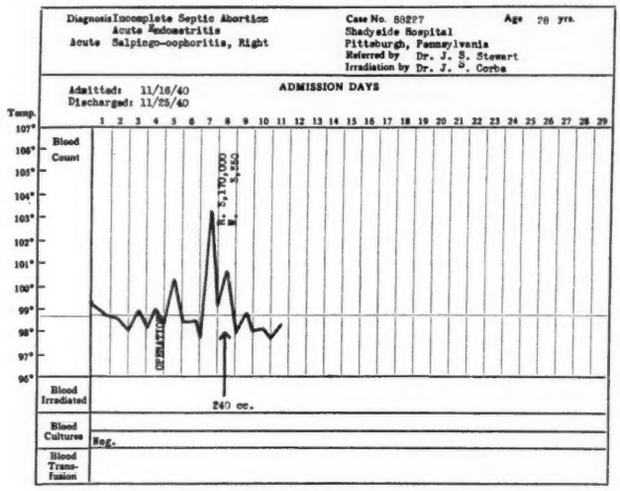


Fig. 4. Case iv.

showed no growth. Gynecological examination revealed an enlarged, softened cervix, bleeding with uterus enlarged to correspond to two months' pregnancy. The right tube and ovary were enlarged and tender. On November 18, the patient received routine curettement for incomplete abortion. At this time not much tissue was recovered, and the curettings sent to the laboratory showed nothing but proliferating endometrium with marked congestion and inflammatory reaction. Diagnosis of pregnancy was not proved by laboratory. By the third postoperative day with chills temperature had reached 103.4°F. She was moderately toxic. On the fourth postoperative day blood irradiation therapy was instituted and as good condition. Her subsequent progress has been uneventful. The right tubo-ovarian infection has not become exacerbated.

Case v. No. 88526. Mrs. G., age twenty-one, married, was admitted to the Shadyside Hospital on December 2, 1940, with a history of a self-induced abortion performed two days prior to admission, at which time her period was approximately two weeks late. She used a catheter for the abortion. Her admission temperature was 102.2°F., pulse 100, respirations 22. She had rather frequent chills, the longest lasting twenty minutes and by the evening of December 3, her temperature reached a peak of 104.6°F., pulse 120. Blood irradiation therapy was instituted on Decem-

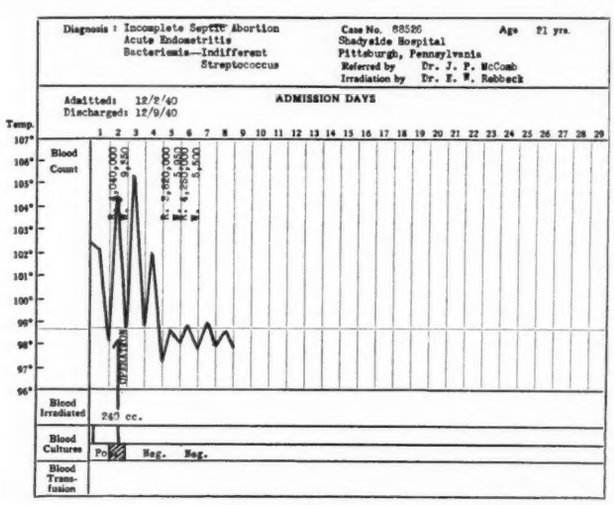


Fig. 5. Case v.

ber 3, and a dilatation and curettage performed on December 4. The pathological report showed early placental tissue with inflammatory reaction. Blood culture taken at the time of the curettement showed indifferent streptococci. Subsequent blood cultures taken December 4 and 5 were negative. A smear from the cervix taken at the time of curettement showed indifferent streptococci. Her temperature reached a peak of 105.2°F. the evening following curettement but, as shown by the accompanying graph, promptly subsided; and the patient was discharged in good condition on December 9, 1940. Her subsequent recovery has been uneventful.

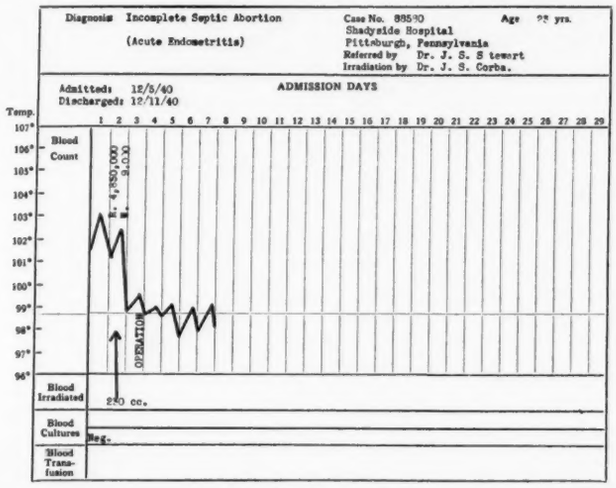


FIG. 6. Case VI.

CASE VI. No. 88580. Mrs. M., age twenty-three, married, was admitted to the Shadyside Hospital December 5, 1940. She gave a history of having missed two menstrual periods. She inserted a catheter into the uterus on November 29. This was followed three days later by chills, severe cramps in the lower abdomen and passage of blood with clots but no fetus. Her admission temperature was 101.2°F., pulse 112, respirations 18. Blood count showed 4,850,000 red cells, 15.4 Gm. hemoglobin, 9,000 leukocytes, 76 per cent neutrophiles (13 filament, 63 nonfilament). Gynecological examination showed blood clots in the vagina; enlarged, softened, patent cervix; bleeding; uterus enlarged to correspond to approximately two months' pregnancy, slightly tender, no adnexal masses or unusual tenderness. Blood cultures taken December 6 and December 7 were negative.

She received blood irradiation therapy on the second admission day, and routine curettement was performed on the third day. No uterine culture was taken. The curettings showed necrotizing placental tissue. As shown by the accompanying graph she made an uneventful recovery and was discharged in good condition on the fourth postoperative day. Her subsequent convalescence has been uneventful.

CASE VII. No. 89678. Mrs. B., age forty, married, was admitted to the Shadyside Hospital on February 4, 1941. She gave a history of missing two menstrual periods prior to January 25, then began to bleed. The bleeding with clots has persisted since. She has six children living and well with a miscarriage four years ago. She denied any attempt at interruption of her pregnancy. Stated that she had had a "cold" for the past two weeks. Her admission temperature was 102.6°F., pulse 128, respirations 24. Blood count showed: red cells 3,410,000; hemoglobin 9 Gm.; leukocytes 11,350; neutrophiles 84 per cent (filament 30, nonfilament 54). A gynecological examination revealed the vagina filled with clots; softened, enlarged, patent cervix with bleeding; uterus enlarged to correspond to ten weeks' pregnancy, slightly tender, no adnexal masses. She received blood irradiation therapy on the second day. The following twenty-four hours her temperature reached a peak of 100.6°F. She received routine curettement on the third day. The pathological report showed necrotizing placental tissue. As shown by the accompanying graph, the patient made a rapid recovery to be discharged on the fifth postoperative day. Her subsequent convalescence was uneventful.

Case viii. No. 92416. Mrs. R., age thirty-one, married, was admitted to the Shadyside Hospital June 23, 1941. Her last menstrual period was due approximately June 14. On June 16, she was given quinine tablets "by some woman" who, likewise, inserted something into her uterus. Aside from an occasional crampy pain nothing happened until June 19, when she began to bleed moderately. The cramps became more severe and she felt warm. No tissue, however, was passed. These symptoms continued until June 21, when she began to have chills and felt considerably warmer. Headache developed and nausea and vomiting. Over the next forty-eight-hour period these symptoms became considerably aggravated with much more severe pain across the lower part of the abdomen, constant and also colicky in nature. The chills increased in severity. When she finally called a physician her temperature had reached 104 degrees on the morning of June 23. She was immediately sent to the hospital. Her admission temperature was 101.4°F., pulse 128, respirations 28. Blood count showed: 3,400,000 red cells, 11.8 Gm. hemoglobin, 14,400 leukocytes, 85 per cent neutrophiles, 21 per cent filament, 64 per cent nonfilament. Pelvic examination revealed a softened cervix with profuse sanguinopurulent, nonoffensive discharge from the cervical canal, filling the vagina. The uterus was enlarged to correspond to six weeks' pregnancy, moderately tender, both lateral regions tender, especially right, no masses. Hot gallon douches of bichloride 1:5000 were given four hourly (we believe for this reason when operation was done, no growth was obtained).

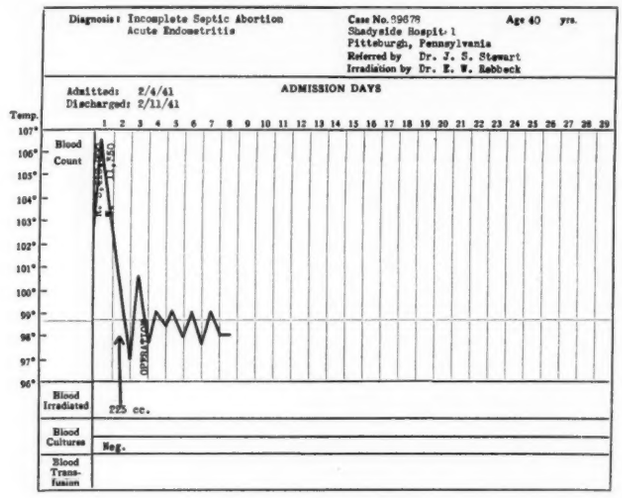


Fig. 7. Case vii.

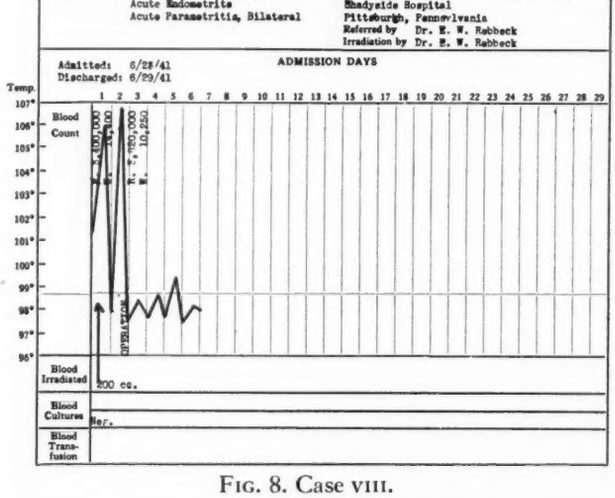


Fig. 8. Case viii.

Blood irradiation therapy was instituted about six hours after admission, and the following day routine curettement was performed. acetone. Her temperature receded by the next day considerably and she felt much improved. On July 2, the second admission day, blood

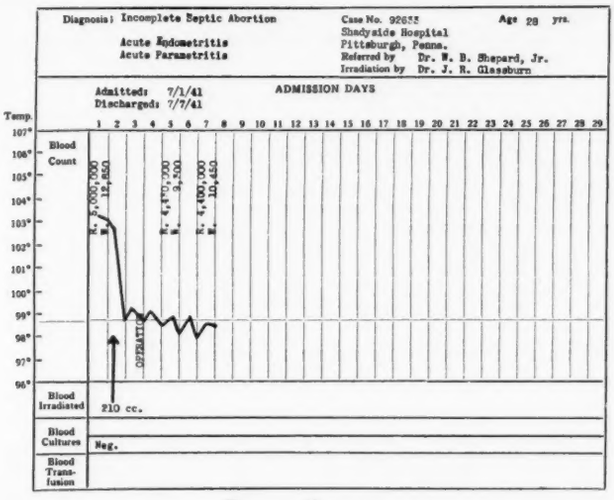


FIG. 9. Case IX.

At operation a small fetus with membrane and decidua was removed. Culture taken from the cervix showed no growth. As shown by the accompanying graph the patient made a prompt recovery, was discharged in good condition on the fifth postoperative day. Examination of the pelvis by her family physician one month later failed to reveal any evidence of pelvic infection.

CASE IX. No. 92633. Mrs. B., age twenty-eight, para 11, was admitted to the Shadyside Hospital July 1, 1941. She gave a history of having had an abortion about four weeks previous, etiology unknown, denied any attempt at interruption, and was apparently about six weeks pregnant at the time. After the abortion she was apparently in good condition until the night of June 30, when she experienced sudden sharp, burning pain over the entire lower part of her abdomen with vomiting. The pain persisted continuously and severe, and was aggravated by urination. On admission an enlarged, softened uterus, quite tender, immobile, was found with bloody serous discharge from the cervical canal. The diagnosis of "frozen pelvis" was made preoperatively. Her admission blood count was 5,000,000 red cells, 86 per cent hemoglobin, 12,850 leukocytes, 83 per cent neutrophiles (66 filament, 17 nonfilament), sedimentation distance 6 mm. in one hour. Her temperature on admission was 103.2°F., pulse 112, respirations 32. Urine showed a moderate number of leukocytes, many erythrocytes and a trace of irradiation therapy was instituted. A culture taken before irradiation showed no growth. Routine curettement was performed on July 3. A moderate amount of purulent endometrial tissue was removed. A pathological examination of the tissue showed endometrium of pregnancy. The culture from the uterus showed diphtheroids. Blood culture taken July 3, was negative. As shown by the accompanying graph the patient made an uneventful recovery and was discharged on July 7, 1941 the fourth postoperative day, in good condition.

CASE X. No. 93021. Mrs. S., age twenty-nine, para 11, was admitted to the Shadyside Hospital July 18, 1941. Her last normal menstrual period occurred two months prior to admission; shortly after that she began to have considerable nausea and vomiting. She claims that she vomited after every meal. She also suffered from urinary frequency and marked constipation. She denied any attempt at self-abortion by instrumentation but admitted taking laxatives and quinine tablets beginning about one week prior to admission. About twenty-four hours prior to admission she began to have considerable pelvic crampy pains, increasing in severity, and a bloody vaginal discharge. Her admission blood count showed 3,530,000 red cells, 12.2 Gm. hemoglobin, 11,450 leukocytes, 84 per cent neutrophiles, (13 per cent filament, 71 per cent nonfilament), sedimentation distance 80 mm. in one hour. Vaginal examination revealed an enlarged, softened uterus, quite tender with

adnexal tenderness, a foul smelling and a profuse discharge from a softened cervix. Her admission temperature was 100.2°F., pulse

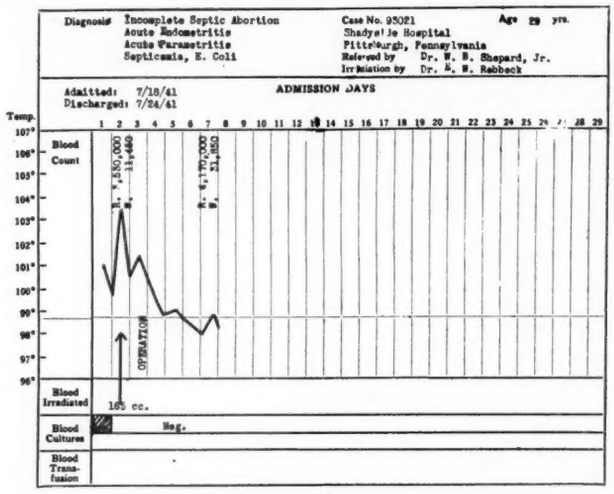


FIG. 10. Case X.

108, respirations 20, and in addition to severe crampy pains in the lower portion of her abdomen she complained of severe pain radiating from the right groin to the right lumbar region as if a pyelitis were developing. Her urine showed considerable albumin, many pus cells and erythrocytes with considerable mucus. She was given blood irradiation therapy in the morning of July 19. A preoperative irradiation blood culture was taken which subsequently showed a profuse growth of escherichia coli. Routine curettement was performed on July 20. The peak temperature during this twenty-four hours being 101.4°F. At operation a considerable amount of foul smelling necrotizing placenta was removed from the uterine cavity. A pathological report showed necrotizing placental tissue. A culture taken from the uterine cavity showed escherichia coli. As shown by the accompanying graph the patient's temperature promptly receded to normal. A blood culture taken July 22, showed no growth. She made an uneventful recovery and was discharged from the hospital symptom free on July 24, 1941.

CASE XI. No 93171. Mrs. G., a negro, age forty, para IV, was admitted to the Shadyside Hospital July 26, 1941. She gave a history of having had a miscarriage at approximately four and one-half months; and on July 24, after some heavy lifting she experienced a sudden onset of crampy pain in her lower abdomen and profuse bleeding. A physician was called and shortly afterward a fetus and placenta were expelled. The bleeding decreased in amount. On the morning of admission she had recurrence of crampy

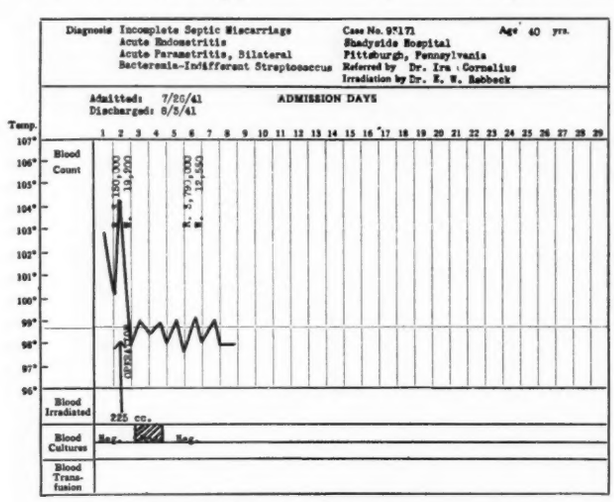


FIG. 11. Case XI.

pains in the lower portion of her abdomen and rather profuse vaginal bleeding with many clots. She had several chills the twenty-four hours prior to admission and had been suffering from considerable nausea and vomiting from the onset of her pregnancy. She denied any attempt at interruption of her pregnancy. Her admission temperature was 102.6°F., pulse 120, respirations 24. Blood count showed 3,150,000 red cells, 11.6 Gm. hemoglobin, 19,200 leukocytes, 73 per cent neutrophiles (38 filament, 35 nonfilament), sedimentation distance 110 mm. in one hour. Urine showed a trace of albumin, many leukocytes and erythrocytes. Vaginal examination revealed the uterus to be enlarged, with softened, enlarged cervix and patent canal; bleeding, with tissue protruding from cervical canal. The uterus was tender as were also the parametrial regions on both sides. Blood irradiation therapy was given on July 26. A blood culture was taken immediately before the irradiation treatment. This culture was negative. Routine curettement was performed immediately. Culture from the uterus showed Staphylococcus aureus in abundance. Blood culture taken immediately after operation showed indifferent streptococci. Blood culture taken July 31, showed no growth. At operation there was a profuse, bloody, purulent discharge from the cervical canal with an offensive odor. The cervix was very patent. The uterus contained a considerable amount of placental tissue with membranes; no fetus. The pathological report showed necrotizing placental tissue. As shown by the accompanying graph there was prompt recession of fever and pulse, and the patient made an uneventful recovery, being discharged on August 3, 1941, the seventh postoperative day, symptom free.

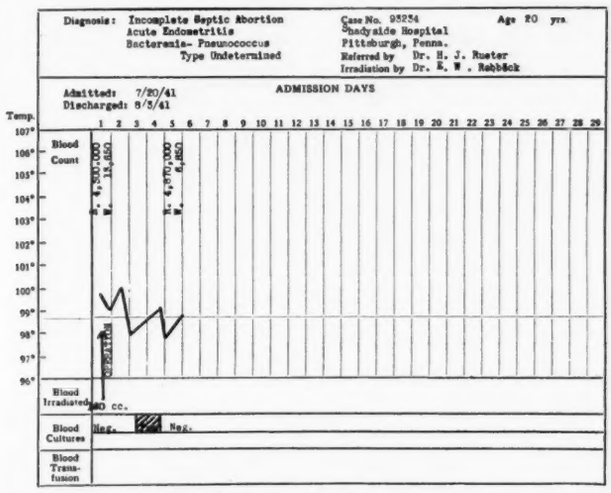


Fig. 12. Case xii.

Case xii. No. 93234. Mrs. O., age twenty, first pregnancy, was admitted to the Shadyside Hospital July 29, 1941. She gave a history of having last menstruated normally late in May, 1941, missed her June period, and approximately July 6; because she felt she was pregnant she began an attempt at interruption of her pregnancy. She admitted attempting to insert a slippery elm stick into her uterus each night for the next two weeks. She had a common cold at the time; no uterine symptoms developed until July 22, when she had frequent chills and a feeling of warmth. On July 23, moderate vaginal bleeding occurred but no cramps. That same evening she passed blood clots and tissue. On July 24, cramps developed, bleeding became worse, but no more tissue was passed. This bleeding continued rather moderately in amount until admission. On July 27, she was examined by her family physician who found a piece of tissue protruding from the cervix and prescribed ergotrate in the hopes the tissue would pass; however, such did not occur and, because the bleeding persisted, she was admitted as noted. Her admission temperature was not taken because of immediate operation. Blood count on admission was 4,300,000 red cells, 87 per cent hemoglobin, 13,650 leukocytes, 66 per cent neutrophiles (56 filament, 10 nonfilament). Vaginal examination revealed bloody vaginal discharge, nonoffensive, a piece of tissue protruding from the cervix, cervix softened, uterus enlarged and softened and moderately tender, no adnexal tenderness or enlargement. The same day of admission the

patient was given preoperative blood irradiation therapy. A blood culture taken immediately before blood irradiation showed no growth. Routine curettement was performed immediately, and a culture taken from the uterus which showed pneumococci of no specific type. A blood culture taken immediately after operation showed pneumococci of no specific type. At operation necrotizing tissue and membranes were removed from the uterus. No fetus was present. The pathological report showed necrotizing placental tissue. A blood culture taken July 31, showed no growth. As shown by the accompanying graph there was mild febrile reaction the next day to 100 degrees with prompt recession. The patient made an uneventful recovery and was discharged from the hospital on the fifth postoperative day, symptom free.

SUMMARY

The use of ultraviolet irradiation of autotransfused blood in postabortional sepsis has markedly influenced the prognosis in this pathological condition. We believe because of the histories of instrumentation, septic fever, pelvic complications and even septicemia very few of these patients would be considered in conventional surgical practice as safe operative risks because of the well grounded fear of spreading infection both locally and into the blood stream. Needless to say, the prevention of the prolonged morbidity, usually found in the conventional handling of such patients, alone is well worth while.

CONCLUSION

Twenty-one patients with postabortional sepsis were treated by ultraviolet irradiation of autotransfused blood. Our experience with this therapy in the treatment of postabortional sepsis prior to and after curettement indicates that in hemo-irradiation we have a valuable adjunct to the practice of surgery. Practically no increase in temperature was noted following surgery when hemo-irradiation was administered preoperatively. Definite protection was afforded against the usual disastrous spread of the uterine infection in the pelvis or into the blood stream. In cases of pronounced sepsis a remarkable reduction in the manifestations of toxemia was achieved. Ultraviolet irradiation of autotransfused blood used as an adjunct in the treatment of septic abortion should prove to be of inestimable value. The accompanying charts and histories* show the cases of postabortional sepsis treated by this method.

REFERENCES

1. Barrett, Henry A. Irradiation of auto-transfused blood by ultraviolet spectral energy: results of therapy in 110 cases. *Med. Clin. North America*, New York No., May, 1940.
2. Barrett, Henry A. The syndrome of the posterior inferior cerebellar artery. A. Cinelli. *Arch. Otolaryngol.*, (in press).
3. Bayne-Jones, S. and J. S. Van der Lingen. The bactericidal action of ultraviolet light. *Bull. Johns Hopkins Hosp.*, 34: 11–16, 1923.
4. Clark, J. H., C. McD. Hill, M. Handy, J. Chapman and D. D. Donahue. Ultraviolet radiation and resistance to infection. *Cong. Internat. Lum. Copenhagen*, 458–463, 1932.
5. Coblentz, W. W. and H. R. Fulton. A radiometric investigation of the germicidal action of ultraviolet radiation. *Sc. Papers Bur. Stand.*, 19: 641–680, 1924.
6. Downes, A. and T. P. Blount. Researches on the effect of light upon bacteria and other organisms. *Proc. Roy. Soc.*, 26: 488–500, 1877.
7. Hancock, V. K. and Knott, E. K. Irradiated blood transfusion in the treatment of infections. *Northwest Med.*, June, 1934.
8. Harris, D. T. *Biochem. J.*, 20: 280, 271, 1926.
9. Macht, D. I. The influence of ultraviolet irradiation of menotoxin and pernicious anemia toxin. *Proc. Soc. Exper. Biol. & Med.*, 24: 966–968, 1927.
10. Mayerson, H. S. and Laurens, H. *Am. J. Physiol.*, 86: 1, 1928; *J. Nutrition*, 3: 465, 1931.
11. Noguchi, H. The photodynamic action of eosin and erythrosin upon snake venom. *J. Exper. Med.*, 6: 252–267, 1906.
12. Miley, G. The ultraviolet irradiation of autotransfused human blood. Studies in the oxygen absorption value. *Am. J. Med. Sc.*, 197: 873, 1939.
13. Miley, G. Ultraviolet blood irradiation: therapy in acute pyogenic infection at Hahnemann Hosp., *Habnemannian Monthly*, December, 1940.
14. Rebbeck, E. W. Ultraviolet irradiation of autotransfused blood in the treatment of puerperal sepsis. *Am. J. Surg.*, 54: 691, 1941.
15. Welch, H. The effect of ultraviolet light on molds, toxins, and filtrates. *J. Prev. Med.*, 4: 295–330, 1930.
16. Wyckoff, R. W. G. The killing of colon bacilli by ultraviolet light. *J. Gen. Physiol.*, 15: 351–361, 1932.

* Due to lack of space only the twelve most interesting case histories are included in this report. The remaining nine histories of cases 73902, 82877, 88216, 89680, 90031, 90388, 90760, 90827 and 90938 can be obtained at Shadyside Hospital, Pittsburgh, Pa.

THE MORTALITY OF CHOLECYSTECTOMY IN THE MALE*

CARL A. BACHHUBER, M.D.
Assistant Clinical Professor of Surgery, College of Medical Evangelists
LOS ANGELES, CALIFORNIA

IN a recent review[1] comparing the statistics on gallbladder surgery performed in a general hospital and a private hospital in this community, a marked difference was noted in the mortality rate in cholecystectomy done on males. In these comparative series of 116 cholecystectomies done at the general hospital there were fourteen deaths, a mortality of 12.06 per cent. In the series done at the private hospital there were forty-five cholecystectomies with two deaths, or a mortality rate of 4.44 per cent.

In view of this striking variance in mortality an endeavor to explain this difference was attempted. Since there are many variable factors involved, a thorough analysis of all pertinent data was undertaken in the hope that the factors responsible for this variation might be found, thereby leading to a substantial reduction in the mortality of cholecystectomy in the male at the general hospital.

It is generally recognized that the mortality of cholecystectomy done on males is higher than that of the female, and also that the male is decidedly a poorer risk insofar as gallbladder surgery is concerned. Cole[2] states that the mortality in the male is 2 to 3 per cent higher than that in the female. Boyce, Veal and McFetridge[3] in an analysis of 404 consecutive surgical cases of gallbladder surgery, place the mortality in the male at 11.9 per cent as compared to 8.1 in the female. Boyd[4] has shown that the mortality in the male is decidedly higher than that in the female, and concludes that the male is a much poorer risk, the older the patient the higher the mortality.

AGE GROUPS

Possibly the fact that the male seeks surgical relief at a later date than does the female may be a contributing factor in the difference of the mortality rate for cholecystectomy between the two sexes; however, the slight difference in the average ages of the two hospital groups for male cholecystectomy cannot be a factor in accounting for the disparity in the mortality rate between the two institutions.

Although there is some variation in the comparative age groups as seen in Table 1, nevertheless, the average age of the patients at the general hospital was 48.56 years, while that at the private institution was 47.75 years, a difference of but .8 of a year, which is rather insignificant. (Table 1.)

PREOPERATIVE STAY

The average preoperative hospital stay at the general hospital was 11.13 days while that for the private institution was 2.6 days. The analysis of the preoperative hospital stay discloses one of the significant factors which definitely contributes to the difference in the mortality rate between the two institutions.

The majority of the patients (seventy-five or 64.65 per cent) were admitted to the general hospital during the acute phase of the disease. Of these eleven or 9.48 per cent of the total male cholecystectomy admissions were operated upon immediately with three deaths, a mortality rate of 27.27 per cent, or 35.34 per cent of the total cholecystectomy mortality. The remaining patients were held until subsidence of the

* From the Surgical Service of the Los Angeles General Hospital and the Department of Surgery, College of Medical Evangelists.

clinical symptoms and were operated upon during the quiescent stage.

Of the sixty-four patients remaining in the group ten died with a mortality of 15.62 per cent or 55.17 per cent of the total mortality. Of the forty-one patients admitted from the out-patient department for elective surgery, one died with a resulting mortality of 2.43 per cent or 9.48 per cent of the total mortality. However, this death was in a patient who had a cholecystostomy elsewhere, and was admitted with a biliary fistula for which surgical relief was sought.

cent of the total mortality. While it is well recognized that the clinical and pathological findings are not always in accord—for many gallbladders will show acute or subacute lesions when removed in so-called quiescent state—nevertheless, contrary to what one would expect, the findings of an acute or subacute lesion at the time surgery was instituted appears to be a minor factor in the mortality rate in this series.

In the private institution, however, forty-two or 93.33 per cent of the patients admitted for cholecystectomy were so-called elective out-patients, only three

TABLE I

AGE GROUPS

	20–29	30–39	40–49	50–59	60–69	70–79	Total	Average Age, Yrs.
General Hospital								
Number	8	19	36	26	25	2	116	48.58
Per cent	6.89	16.38	31.03	22.41	21.55	1.72		
Private Hospital								
Number	0	7	19	11	6	2	45	47.75
Per cent	0	15.55	42.22	24.44	13.33	4.44		

As shown above, the acute group of admissions, namely, seventy-five patients, accounted for over 90 per cent of the total mortality. Therefore, any improvement in the mortality rate of male cholecystectomy which can be made must be made in this group. Since eleven of the above group were operated upon as emergencies and were patients who were desperately ill, there is no doubt that a definite reduction in mortality rate can be accomplished by the performance of a cholecystostomy in place of cholecystectomy.

However, since the group which was operated upon immediately accounted for only 35.34 per cent of the total deaths a striking reduction in mortality rate can only be achieved by reducing the death rate in the group of patients who were operated upon after subsidence of the clinical symptoms and accounted for 55.17 per

being admitted during the acute phase of the disease. One of these was operated upon immediately, the preoperative diagnosis being perforated peptic ulcer, and the remaining two were operated upon a few days after admittance, the acute attacks being rather mild and subsiding rapidly.

Of the two deaths which occurred in the elective out-patient group one could possibly be classed as a surgical accident and in the second death the patient apparently was an extremely poor risk for the post-mortem examination showed coronary disease, arteriosclerosis, fibrous myocarditis, recent myomalacia, bronchiectatic abscess of the lower lobe of the left lung; in addition the patient was diabetic.

Since the percentage of cholecystostomies performed at the private hospital is about 2½ to 1 performed at the general hospital, it appears that most patients with

an acute or subacute cholecystitis that are operated upon at the private hospital have a cholecystostomy performed.

PATHOLOGICAL LESIONS

In a review of this type the severity of the pathological lesion present at the time of the surgery must be given serious consideration for as a rule one would expect more deaths in the group in which the gallbladder was still acutely or subacutely inflamed at the time of its removal. We must also appreciate the fact that although the clinical signs have subsided, the gallbladder may still present signs of acute or subacute inflammation at the time of its removal. It is for this reason that sufficient time should elapse after the acute attack before instituting surgery to allow for complete subsidence or resolution of the pathological process.

However, in reviewing the pathologist's report in this series of cases one is forced to conclude that the acuteness of the lesion played a minor part in producing the difference in mortality between the two institutions.

In the three deaths occurring following surgery immediately upon admittance, the pathologist reported chronic cholecystitis in one, empyema in the second, and the report of the third was not available due to the fact that the patient had had a cholecystectomy elsewhere and was admitted to the general hospital for postoperative dehiscence and duodenal fistula.

In the group admitted for surgery from the out-patient department there was one death as mentioned. The patient had had a cholecystostomy elsewhere and was admitted for treatment of a gallbladder fistula.

The pathological lesions present in the patients who died following cholecystectomy at the general hospital after the subsidence of the clinical symptoms are as follows: chronic cholecystitis 5, subacute 2, hydrops 1, recent acute 1, and gangrene 1.

From the foregoing one is justified in concluding that the acuteness of the lesion can only be considered a lesser contributing factor.

TYPE OF OPERATION

In a review of the gallbladder surgery done at the general hospital covering a five-year period it was found that in seventeen surgical accidents in which the method of removal was stated the gallbladder was removed from the duct to the fundus in fifteen instances. Since the mortality rate of surgical accidents is near 50 per cent, the possibility that the type of operation may have been a contributing factor in the mortality rate must be considered.

However, in the analysis of the male cholecystectomy deaths from the series at the general hospital in which the method of removal was stated three were removed from the fundus to the duct, four from the duct to the fundus and in the remaining seven the method of removal was not stated.

As to the private hospital, in one death the method of removal was not stated and in the other the removal of the viscus was attempted from the duct to the fundus; but owing to the technical difficulties encountered this procedure was abandoned and the removal completed from the fundus to the duct.

From the above it would appear that the method of removal played no prominent part in the mortality rate as far as the general hospital is concerned, but apparently was a factor in the death at the private institution.

DRAINAGE

The failure to institute drainage played no part in the mortality rate for in the deaths at the general hospital eleven were drained, one not drained, and two were not stated. In the two deaths at the private hospital both patients were drained.

CALCULOUS AND NONCALCULOUS CHOLECYSTITIS

Although the mortality rate is higher in calculous than in noncalculous cholecysti-

tis, it appears from the comparative statistics to have played no rôle in the difference in the rate between the two institutions.

SECONDARY SURGICAL PROCEDURES

The most frequent secondary surgical procedure performed at both hospitals was appendectomy. As a rule the removal of an incidental appendix carries with it no additional risk as shown by Boyd.[4]

In the series of deaths at the general hospital appendectomy was performed in two patients while in the two deaths at the private hospital neither had had an appendectomy. However, after completion of a cholecystectomy an incidental appendectomy revealed a retrocolic abscess with resulting deaths of the patient.

In comparing the two groups of male cholecystectomies incidental appendectomy was performed in sixteen instances or in 13.79 per cent at the general hospital, while in the private hospital appendectomy was performed in twenty-four instances or 53.35 per cent.

From the comparative statistics incidental appendectomy of nonacute appendices played no part in the difference in the mortality between the two institutions.

However, the unfortunate experience mentioned could be avoided if the incidental appendectomy proceeds the cholecystectomy.

As to other surgical procedures in the combined groups there were two gastroenterostomies, one pyloroplasty and repair of two incisional herniae without a death. The secondary surgical procedure did not contribute to the difference in the mortality.

DEATHS

In the final analysis of the deaths at the general hospital the outstanding fact is that all the deaths but one occurred in the patients who were operated upon as emergencies or immediately following the subsidence of the clinical symptoms.

Since in the private hospital with the low mortality rate practically all male patients for cholecystectomy are admitted as ambulatory out-patients, one is compelled to conclude that the cholecystectomy should not be performed immediately upon subsidence of the clinical symptoms. These patients should be dismissed from the hospital for a period of six weeks to two months and an attempt made during the interim to improve the patients' general condition.

In classifying the deaths which occurred in the general hospital series the following causes are found: bronchopneumonia three, postoperative hemorrhage three, retrocolic abscess one, acute cholecystitis one, aspiration pneumonia one, subphrenic abscess three, duodenal fistula one, pyemic abscess of kidney one.

Thus it appears as though the infection was responsible for nine deaths, hemorrhage for three, questionable postoperative care for one, and surgical accident for one.

Since next to infection postoperative hemorrhage played an important part in the mortality, it appears quite likely that this complication is far more frequent when surgery is performed immediately after subsidence of the clinical symptoms.

CONCLUSIONS

The death rate in male cholecystectomy can be appreciably reduced by the proper application of certain sound surgical principles in which controllable circumstances appear to be a definite contributing factor to the mortality:

1. All patients who are admitted as emergencies and not operated upon as such, should be dismissed from the hospital after subsidence of the clinical symptoms and be readmitted at a later date for surgery as ambulatory elective patients. A minimum time of six weeks to two months should be allowed to elapse before surgery is instituted during which time the patient's general condition should be improved as much as possible.

2. If a patient is being operated upon for cholecystitis and the findings upon opening

the abdomen are such to cast doubt on the diagnosis, exploration of the abdomen should precede the cholecystectomy.

3. Removal of an incidental appendix should precede the cholecystectomy.

4. If the gallbladder appears acutely inflamed at the time of an elective cholecystectomy, cholecystostomy is the operation of choice.

5. The more frequent removal of the gallbladder from the fundus to the duct will reduce the number of surgical accidents and thereby contribute to the reduction of the mortality.

6. The routine use of the Levine nasal tube would no doubt not only aid in preventing aspiration pneumonia, postoperative vomiting, gastric dilation, and abdominal distention, but also reduce the percentage of postoperative herniae.

Although the above conclusions are undoubtedly open to criticism, nevertheless, the recommendations and conclusions enumerated quite likely will reduce the mortality rate in cholecystectomy done in the male in the hands of the average surgeon.

REFERENCES

1. Bachhuber, Carl A. *West. J. Surg.*, 49: 203–207, 1941.
2. Cole, Warren H. *Internat. Abstr. Surg.*, 69: 40–46, 1939.
3. Boyce, Frederick Fitzhubert, Veal J. Ross and McFetridge, Elizabeth. *Surg., Gynec. & Obst.*, 63: 43–53, 1936.
4. Boyd, Philip. *New England J. Med.*, 218: 1045–1050, 1938.

Correction: In our January (1942) issue an article was published entitled "Stab Wound of the Heart" by Dr. Robert E. Carter. The author now wishes to correct his original legend to Figure 3 on Page 145. It should read: "Patient sustained stab wound of heart. He was operated upon in June, 1938. This picture was taken ten days postoperatively."

ABDOMINAL NEURALGIA IN RELATION TO THE SUPERFICIAL ABDOMINAL NERVES*

JOHN L. INGHAM, M.D.
Assistant in Urology, Easton Hospital, and Warren Hospital, Phillipsburg, New Jersey
EASTON, PENNSYLVANIA

A PRECISE knowledge of the distribution of the nerves of the abdominal wall is of great aid in the intelligent handling of abdominal pain of neuralgic origin. It is commonly recognized that the lower intercostal and upper lumbar nerves supply cutaneous and other branches to the abdomen. When it is known where these branches lie, it is possible to strengthen the diagnosis of neuralgia by pressure over them. However, in no discussion of this subject consulted, is there an attempt to locate the branches for this purpose. It should be emphasized that they are mixtures of filaments of the lower intercostals, iliohypogastric and ilioinguinal containing fibers from the seventh thoracic to the second lumbar nerves.

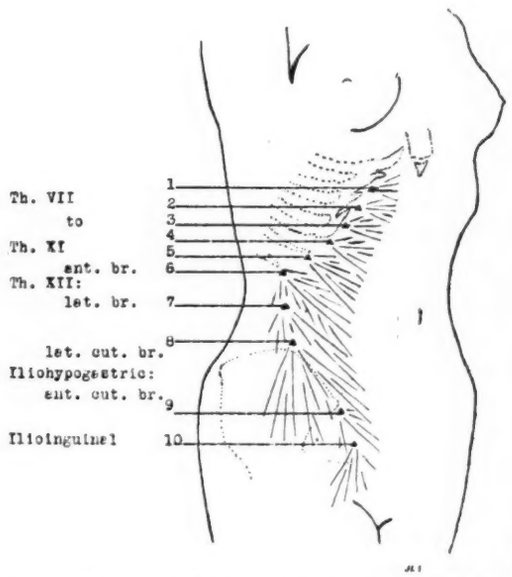


FIG. 1. Points at which the nerves of the abdominal wall become relatively superficial. Distribution and main nerve components indicated.

ANATOMY

The numbered triangles of Figure 1 represent the points where the superficial nerves of the abdominal wall first come to lie, fully formed, beneath the aponeurosis of the external oblique. Their distribution is indicated by shading. The points have been numbered to clarify explanation of the cases presented. Most textbooks of anatomy draw these nerves in diagrammatic fashion and give a less exact description of their distribution than is merited by their size and constant position. They are described here as established by cadaver dissection;† in the living subject, their positions may be verified by eliciting hyperesthesia on pressure over them just as pressure over other sensory nerves produces an uncomfortable hyperalgesia.

Points 1, 2, 3 and 4 lie along the abdominal margins of the eighth, ninth and tenth costal cartilages. Point 5 lies just below the end of the eleventh rib. Point 6 lies at the tip of the twelfth rib. Point 7 is midway between 6 and 8; point 8 is just above the highest part of the crest of the ilium; point 9 lies just above the iliac insertion of the inguinal ligament, and point 10 at the midpoint of the inguinal canal.

In our cases of abdominal neuralgia, the pain lay in the areas indicated by shading for each branch involved. Search for and pressure on the corresponding nerve points, gave corroboration of the diagnosis; these were exquisitely tender. Points 6, 7 and 8 were the most commonly involved.

† Laboratory of surgical anatomy, University of Pennsylvania Graduate School of Medicine, 1935 to 1936.

* From the Genitourinary Clinics and Department of Urology, Easton (Pa.) General Hospital.

INJECTION

Advantage is taken of the rather superficial position of the nerves in confirming the diagnosis by procain block. They can be reached by a hypodermic needle, long or short depending on the pannicular thickness. The position of the most tender spots, corresponding to the numbered triangles of Figure 1, are marked with colored skin antiseptic and a skin wheal raised with procain.

The needle is inserted until it passes through the deep fascia; it is important that it penetrate this tissue since the nerve lies beneath. The nerve may be searched for by probing with the tip although this is not necessary. Two cc. of procain should suffice to relieve the abdominal pain within a minute.

In our hands, relief has been complete enough to establish the diagnosis, but has been so temporary (three to four hours) that we routinely follow with from 0.5 to 1.0 cc. of 95 per cent alcohol. If there is a burning sensation, a few more drops of procain will alleviate it.

DISCUSSION AND CASE REPORTS

The procain-alcohol technic has proved diagnostically positive and therapeutically easy in seven cases of abdominal neuralgia seen in a six-month period in clinic and ward practice; private cases have not been included in this survey. The number of cases is probably larger than will be seen in a similar period hereafter, since many have gone undiagnosed from clinic to clinic for several years. Cases are presented in Table 1.

It is interesting to note that five of the seven cases showed a spinal abnormality. Three of the patients *x*-rayed had spondylitis and one a unilateral iliac wedging. One other patient had a postural scoliosis due to shortening of one leg. All were accompanied by genitourinary disease, but none of a degree severe enough to account for the amount of associated pain.

TABLE I

Patient	Location of Pain	Duration of Pain	Previous and Concurrent Diagnoses	Points Injected	Solution Injected	Date	Relief
1. #h91595, W. M., age 68	right abdomen	3 years	prostatic hypertrophy, ureteritis, vesiculitis, acute upper abdomen, marked spondylitis	R7, 8, 9	procain	4-23-40	temporary
				R7, 8, 9	procain-alcohol	4-30-40	permanent
				R3, 4, 5, 6	procain-alcohol	5- 3-40	permanent
2. #h75610, #c11333, W. M., age 39	right flank and right lower quadrant	8 years	pyelitis, appendicitis, colitis, lues, anemia, hemorrhoids	R5, 6, 7	procain-alcohol	5-28-40	permanent
				R8	procain-alcohol	6- 3-40	permanent
3. #c15591, W. M., age 34	right flank, right hip and thigh	5 years	pyelitis, prostatovesiculitis, healed fractures of second and third lumbar bodies	R7, 8	procain	6-24-40	temporary
				R7, 8	procain-alcohol	7- 2-40	permanent
4. #c13306, #h92732, W. F., age 19	l., abdomen	3 years	salpingitis, endometritis, postural scoliosis and lordosis	L7, 8	procain	9- 9-40	four hours
				L7, 8	procain-alcohol	9-16-40	four hours
				L6	procain-alcohol	9-23-40	unsatisfactory
				L5	procain-alcohol	10-21-40	unsatisfactory
5. #h91365, W. F., age 54	l., hypochondrium; l., hip and thigh; l., abdomen and flank	2 weeks	nephroptosis; spondylitis	L6, 7	procain	4- 8-40	temporary
				L6, 7	procain-alcohol	5- 6-40	permanent
				L8	procain-alcohol	10- 4-40	permanent
6. #c15126, W. M., age 28	left lower quadrant	2 weeks	incipient l., hernia; urethral stricture	L7, 8	procain-alcohol	10-15-40	permanent
7. #h93867, #c15013, W. F., age 22	right abdomen	1 year	pyelitis, appendicitis, salpingitis, sacro-iliac abnormality	R4, 5, 6, 7	procain-alcohol	8-19-40	four days

Remarks:
1. (W. S.) Fifth 1. intercostal injected at midclavicular line, 12-3-40, for "heart pain."
2. (S. L.) Slight return of pain during heavy work. Had not worked for eight years.
3. (P. K.) Lateral femoral cutaneous nerve injected (in quadratus m.) at same time.
4. (H. K.) Pressure points insensitive after treatment, but pain persisted in left rectus region.
5. (M. B.) Pain of upper abdomen and hip, less severe, abated between injections.
7. (S. H.) Negative laparotomy, 9-6-40; pain persists (response to questionnaire).

That the described method is not therapeutically perfect can be seen by our failure to achieve lasting relief in two cases. Case 4 has been relieved by orthopedic measures. Case 7 has not returned, following a futile laparotomy. Her pain was stopped for only four days in the region injected. While such cases demonstrate the diagnostic value of superficial injection, they also emphasize the extent to which the syndrome requires general, as well as local treatment. The possibility of an induced alcoholic neuritis should mitigate against repeated injection.

SUMMARY

1. The diagnosis of abdominal neuralgia may be strengthened by finding markedly increased tenderness over the superficial nerves of the abdominal wall.

2. The position of these nerves is located and described.

3. Procain injection at the described points relieved neuralgic pain in seven cases presented. Permanent relief was obtained by addition of alcohol in five cases.

Correction: In the December (1941) issue of the American Journal of Surgery there appeared a paper on "Postoperative Evisceration" by Dr. Morris L. Bobrow in which the statements were made " . . . there is no legal standard of catgut gauge and strength in the United States," and " . . . most companies have adopted the Federal specifications as their standard," which specification, it is pointed out, has no legal status.

This is incorrect. Under the new Food & Drug law, all catgut standards as published in the U. S. Pharmacopoeia, Second Supplement of the 11th Revision, have been mandatory standards on all manufacturers. Material which does not measure up to these standards is subject to seizure by the Department of Agriculture; in fact, most governmental agencies have adopted these U.S.P. standards. These U.S.P. standards have been in effect for nearly a year and a half.

ACUTE APPENDICITIS IN CHILDREN*

PHILIP D. ALLEN, M.D.
Associate Surgeon, Bellevue Hospital
NEW YORK, NEW YORK

THIS study of acute appendicitis in children is based on 293 consecutive cases occurring on the Children's Surgical Service at Bellevue Hospital for the five-year period from 1936 to 1940, inclusive. Comparisons are made to a similar report made by the writer,[1] in 1937, covering the ten-year period from 1926 to 1935, inclusive. All children included in this series suffered from acute inflammation of the appendix, confirmed pathologically. The same group of surgeons operated upon these patients, and the same method of classification has been used as in the preceding series, namely, (1) unperforated; (2) abscessed; and (3) spreading peritonitis.

The previous series consisted of 612 patients, among whom there were thirty-six deaths, or a death rate of 5.8 per cent. Beekman[2] made a still earlier report of 145 cases from this service, with a death rate of 7.58 per cent. The present group consists of 293 patients, with five deaths, or a death rate of 1.7 per cent. Among these children there were thirty-one who had not reached their fifth birthday, with one fatality. This mortality rate of 3.2 per cent for infants and younger children compares favorably with a mortality rate of 25.6 per cent for the same age group reported by Beekman,[3] and which has been reduced to 15.2 per cent in my last report.

This marked improvement in mortality statistics leads to a consideration of the factors we deem responsible. These should be divided into two groups: First, those occurring before the patient entered the hospital, and, secondly, the preoperative, operative and postoperative management of these children. It is noted that the patients in this series applied for admission to the hospital on an average of thirty-four hours after the onset of the disease, whereas in the old series fifty-two hours had elapsed. The factor of catharsis also shows a trend in the right direction. Forty-nine per cent of the patients in the previous series had received cathartics, whereas in this series it has been reduced to 36.8 per cent. This would seem to indicate that the attempt at education of the public by radio and public press is bearing fruit.

In the previous series, 51 per cent of the patients were in the unperforated group, the rest being almost equally divided between spreading peritonitis and abscess groups. In this series, 66.5 per cent were unperforated at the time of operation. The earlier admission of these children, and the fewer who had had cathartics administered, most likely accounts for the greater number being in the less serious group.

The preoperative management of these patients has materially changed since my last report. In the former group of patients the average time elapsing between their admission to the hospital and the operation was 3.9 hours. In this group the time was almost doubled, 7.5 hours having elapsed. We have, therefore, been much less hasty in getting these patients to the operating room. We still aim at immediate operation in a child suffering from early acute appendicitis who is in good fluid balance. However, in children with evidence of spreading peritonitis who are dehydrated from long continued vomiting, we find much has been gained by a few hours of preoperative management aimed at correcting fluid balance. While this is being done the distention may be reduced by the use of a Levin tube attached to a Wangen-

* From the Children's Surgical Service, Bellevue Hospital, New York, N. Y. Read before the New York Surgical Society, February 26, 1941.

steen suction apparatus, together with general supportive treatment. Blood transfusions are occasionally administered at this time. The majority of these children are changed from very poor operative risks to relatively good ones in six to eight hours. In the old series preoperative infusions were rarely if ever administered, whereas in this group eighty-five patients or 29 per cent of them received one or more preoperative infusions, usually with normal saline and 5 per cent glucose. In very few instances in which this procedure was followed did we note a tendency for the clinical appearance to become worse.

In not a few children, admitted with a diagnosis of appendicitis with spreading peritonitis, we were able to correct our diagnosis while fluid balance was being established. The diagnosis of primary peritonitis of either pneumococcic or streptococcic origin has frequently been made during this time and premature operation thereby avoided.

The technic of the operations in this group has not varied much from that in the previous one, except that in that group a right rectus incision was used in 95 per cent of the cases, whereas in this group it was employed in only 7 per cent. A McBurney incision was used in 93 per cent of this series. This incision provided a more direct approach to the diseased appendix together with less trauma to the uninfected portions of the peritoneal cavity. In cases in which drainage is employed it decreases the chance of the drain lying in contact with a clean loop of intestine, as was frequently the case when a right rectus incision was used. The method of handling the stump is about equally divided between inversion and simple ligation. The condition found at operation frequently decides this procedure. In cases in which drainage is expected to be extensive, we have continued to be enthusiastic with the practice whereby only the peritoneum is closed with interrupted sutures down to the drain and the remaining layers of the abdominal wall left open to be packed loosely with vaselined gauze. More recently, in patients presenting evidence of early peritonitis in which the fluid is turbid but not actually purulent, we frequently close the peritoneum without drainage and leave the other layers of the abdominal wall open. To date we have had no reason to regret this procedure but our experience has been insufficient to comment positively on its value.

In eight instances in this series the appendix was not removed at the time of operation. These were all in patients who presented large thick-walled abscesses, and drainage was instituted attempting to preserve as much as possible nature's architecture of the cavity. Seven of these children recovered and one died. Of the seven who recovered four returned in about three months for appendectomy. Two have been lost to follow-up and the other one is symptom free. We always advise the parents that the appendix has not been removed and urge its removal within a few months.

Anesthesia. In 1935, the anesthesia department at Bellevue Hospital was reorganized under the directorship of Dr. E. A. Rovenstine. All anesthesias are administered by the physician-anesthetists under his direction. No fixed opinion is held as to the best anesthesia for appendectomy but consideration is given to the physiologic disturbances that are present. Every patient is individualized as to the proper anesthetic procedure. Children six years of age and over are prepared with morphine and atropine or scopolamine, whereas infants and younger children receive atropine only. The carbon dioxide absorption technic is usually employed since with its proper application oxygen want and carbon dioxide excess are eliminated, respirations are more like those of normal sleep and adequate relaxation is secured with a minimum of agent. Ether and cyclopropane are the drugs most often employed and nitrous oxide is used only for induction.

During operation the airway is kept unobstructed; the status of the circulation

is followed at short intervals with determinations of the blood pressure and pulse rate. Treatment is immediately instituted to prevent serious consequences from such emergencies as circulatory collapse, vomiting, excessive mucus or increasing body temperatures.

We are convinced that the advances made by the anesthesia department played a big part in our lowered mortality rate as well as the improvement in morbidity. Postoperative pulmonary complications have been reduced to a minimum. No patients has been lost on the table, and none of the deaths in this series can be attributed in any way to the anesthesia.

In the previous group of patients twelve, or one-third of the thirty-six deaths, occurred within twenty-four hours after operation. One patient died on the operating table, one died within twelve hours of shock, and in all the others profound toxemia was noted, with several expiring before reaction from anesthesia was complete. We believe that with the present preoperative care aimed at correcting fluid balance, together with the improved methods of anesthesia, many of those deaths might have been averted.

The postoperative management of these children has not changed materially except that we are definitely more alert in watching for clinical and laboratory evidence of fluid imbalance. There is also a tendency to the earlier use of the Levin tube, more as a preventive of distention than as a cure for long continued distention, as was the practice in the earlier days. Blood transfusions have been administered more freely. Oxygen therapy has been employed in a few cases in which there was extensive peritonitis. The sulfonimide drugs have been used in the majority of cases with spreading peritonitis and, more recently, in a few instances we have used sulfanilamide locally in the peritoneal cavity and in the operative wound. We have not been impressed with this drug as influencing the course in any of these patients. However, it has been used in too few to draw definite conclusions.

The number of days in the hospital has been reduced in this series as compared to the old, the previous group having remained in the hospital on an average of 21 days, whereas in this group it was only 15.6 days. We believe this can be chiefly attributed to the use of the McBurney incision in addition to the fact that in a larger percentage of the patients the appendix was not perforated at the time of operation.

Unperforated Group. There were 195 cases, or 66.5 per cent of the series, in which the appendix was not perforated at operation. These children had been ill on an average of 27 hours at the time of admission, and an average of 6.8 hours transpired from admission to operation. One death occurred in this group.

Case 1. T. N., a white female, age nine, complained of generalized abdominal pain and vomiting for four hours. She had suffered three previous similar attacks. There was local tenderness over McBurney's point. Her temperature was 99°F.; leukocytes 13,100, 89 per cent polymorphonuclears. She had a mild head cold but appeared in good general condition. She was operated upon within two hours of admission. An acute, unperforated appendix covered with fibrin was removed through a McBurney incision, the stump being inverted. A small rubber dam drain was inserted down to the peritoneum at the lower angle of the wound. The fever rose to 103°F. within twenty-four hours and remained high. Distention became marked on the third day. All sutures were removed and extensive fascial slough was present on the fourth day. The Wangensteen suction apparatus was used together with hot stupes and repeated enemas. She died on the thirteenth postoperative day, apparently of diffuse peritonitis.

Abscess Group. Twenty-six patients presented abscesses at the time of operation, which was performed on an average of 14.7 hours after admission. These children were admitted eighty-eight hours after the onset of their disease, which is a marked

reduction from the one hundred forty-seven-hour average in the same group of the previous series. One fatality occurred in this group.

Case II. L. P., a male, age nine, had been ill five days with abdominal pain which at first was general and later became localized. He had not vomited. A previous similar attack had occurred one month earlier. A cathartic had been administered in this instance. His temperature was 100.6°F.; leukocytes 12,700, 83 per cent polymorphonuclears. The abdomen was moderately distended. Tenderness and rigidity were localized to the right lower quadrant. Through a McBurney incision, a thick-walled abscess was found in the right gutter. No attempt was made to remove the appendix but the abscess was drained and the abdominal wall left open. After operation, distention persisted, drainage was never satisfactory and on the ninth day the temperature rose to 106°F. An ileostomy was then performed but no drainage was obtained. He expired on the twelfth postoperative day. Autopsy revealed a diffuse peritonitis.

Spreading Peritonitis. Seventy children in this series presented spreading peritonitis at the time of operation. This was 24.5 per cent of the entire group, which is the same proportion with this phase of the disease as was noted in the previous series. These patients were admitted on an average of thirty-four hours after the first symptom was observed, and six and eight-tenth hours was consumed in preparing them for operation. There were one operative and two nonoperative deaths in this group, a mortality rate of 4.2 per cent.

Case III. T. V., a white, male, age ten, had suffered generalized abdominal pain without localization and vomiting for eighty-two hours. He had been given a cathartic and repeated enemas. His temperature was 101°F.; leukocytes 18,200, polymorphonuclears 82 per cent. He was dehydrated and his abdomen was distended. There was generalized abdominal rigidity. A mass was palpated by digital examination of the rectum. A gangrenous perforated appendix with spreading peritonitis was found at operation, a right rectus incision being employed. A drain was placed into the pelvis and one into the right gutter, the peritoneum being closed about the drains. The rest of the abdominal wall was left open. The course was rapidly downhill, with high fever, uncontrollable distention, and rapid respirations and death occurred on the fifth postoperative day. No necropsy was obtained but death was obviously due to diffuse peritonitis.

Nonoperative Deaths. Case IV. B. C., a white, female, age two and one-half years, had had a severe cold with cough for two weeks. For forty-eight hours there had been anorexia, vomiting and fever. No history of pain could be elicited. Her abdomen was rigid throughout. Her temperature was 103.6°F.; pulse 144; leukocytes 18,800, falling to 8,800 in twenty-four hours. She was dehydrated and toxic. The patient did not improve with infusions, transfusion and sulfanilamide therapy but became rapidly worse, dying fifty-seven hours after admission. Necropsy revealed a general peritonitis with a ruptured appendix lying in an abscess cavity in the right gutter. One naturally speculates as to the result had drainage been instituted within a few hours after admission. From the rapid downhill course presented by this infant it is doubtful that operation would have influenced the outcome.

Case V. A. F., a white, female, age six, had had generalized abdominal pain and vomiting for fifty-six hours previous to admission. Her temperature was 104°F.; pulse 130; leukocytes 19,000, 86 per cent polymorphonuclears. The abdomen was distended and rigid throughout. The father refused to allow operation in this instance. Morphine sulfate in $\frac{1}{12}$ gr. doses was administered every four hours. Infusions, one transfusion, and sulfanilamide were given. A peritoneal tap revealed a Gram-negative bacillus. She died in forty-six hours, the course being progressively downhill. Autopsy revealed a generalized peritonitis, the tip of the appendix being gangrenous and perforated. There had been no attempt at any localization.

Complications. The convalescence of these patients has been noticeably smoother than in the previous group. Serious complications have been few. Pneumonia occurred in only two patients, and one of the older children had a definite atelectasis. All of these recovered. Retention of pus in the pelvis occurred in eleven instances. All of these recovered without any secondary

operative procedure, most of them draining through the original drainage sinus. Four of these drained spontaneously through the rectum. All of them were treated with hot rectal irrigations, twice daily, in addition to poultices or stupes to the abdomen.

A fecal fistula occurred in one patient, which closed spontaneously. This patient also developed a phlebitis of the right saphenous vein but was discharged in good condition on the thirtieth day after operation.

Partial dehiscence occurred in two patients in both of whom only the peritoneum had been closed. In one instance a loop of small intestine presented and was packed back with vaselined gauze. The wound healed firmly. In the other case through-and-through silk sutures were used after the small intestine and omentum were replaced. The wound in this patient was healed on discharge but the case has been lost to follow-up.

Retention abscesses have continued to be a common complication. They occurred in fifteen instances in which the wound had been closed without drainage, necessitating opening the wound widely down to the fascia. In one of these patients there was a large abscess in the right iliac fossa. There were 135 patients who were closed without drainage. We, therefore, had an infection rate of 11.1 per cent as compared to 25.6 per cent in the old series. In eleven instances among thirty-eight cases, in which there had been a small drain placed down to the peritoneum, it was later necessary to open the wound for more adequate drainage.

In one patient in whom a McBurney incision was used and the wound left open, a severe hemorrhage occurred about twenty-four hours later. The wound was packed. Four transfusions were administered, and he was discharged with the wound completely healed on the thirty-sixth day. One child suffered a severe iodine burn of both groins.

Follow-up. We were successful in following 80 per cent of our patients in the Follow-Up Clinic. In this series there have been three postoperative herniae. In four instances a bulge and slight weakness were noticed during the first few months of observation, only to disappear at the end of the year. Since 1926, we have been successful in following 220 patients in whom only the peritoneum was sutured down to the drain at the time of operation. There have been seven herniae in this group, an incidence of 3.1 per cent. During that same period, 187 patients have been followed-up in whom drainage was instituted by the old method, namely, the suturing of all layers of the abdominal wall down to the drain. Eight herniae were noted among these, an occurrence rate of 4.2 per cent.

SUMMARY

Two hundred ninety-three children suffering from acute appendicitis have been analyzed. Five deaths occurred in this group, two of which were nonoperative. This is a marked reduction in death rate as compared to previous reports from the same service. Among the outstanding reasons assigned for the lowered mortality rate are: (1) earlier hospitalization; (2) fewer cathartics; (3) more preoperative care aimed at correcting fluid balance, especially in toxic dehydrated patients with evidence of spreading peritonitis; (4) better anesthesia and (5) the use of the McBurney incision. This incision is likewise believed to have been the chief factor in reducing hospital stay from twenty-one days in the previous report to fifteen and six-tenth days in this series. Further follow-up observations in cases in which drainage was employed and in which only the peritoneum was sutured is reported, with a decreased incidence of hernia in this group.

REFERENCES

1. Allen, P. D. Acute appendicitis in children. *J. A. M. A.*, 109: 121–125, 1937.
2. Beekman, F. Acute appendicitis in childhood. *Ann. Surg.*, 79: 538, 1924.
3. Beekman, F. Acute appendicitis in the infant. *Ann. Surg.*, 80: 911, 1924.

GASTRIC RESECTION FOR ULCER*

EXPERIENCE IN FORTY-FOUR CASES

C. FREMONT VALE, M.D.

Associate Surgeon, Harper Hospital; Clinical Professor of Surgery, Wayne University School of Medicine; Attending Surgeon, Receiving Hospital

DETROIT, MICHIGAN

THE trend toward high resection for ulcer is justified by the increasingly favorable long range results as compared with those following lesser operations, together with a lowering mortality rate as wider experience is obtained.

This series of forty-four cases is reported, not because of any excellency of results, but to suggest certain factors which we believe have enabled us to operate upon these patients more safely. It is recognized today that our medical colleagues can treat successfully over 85 per cent of duodenal ulcers. It is with the small fraction who cannot be relieved by conservative measures that we are concerned.

It is constantly asked why some cases are so resistant to treatment when the great majority are controlled. We cannot answer this question completely. Possibly all would be amenable to a rigid régime instituted early in the disease. However, the local duodenal pathological condition seen at operation is enough to explain such resistance. In all of the patients upon whom I have operated for this reason there has been a more or less extensive duodenitis with an open ulcer appearing only as an area of greatest acuteness. Without exception all have been adherent to the pancreas. The wall has been thickened and stippled over a wide area. When the duodenum has been opened, the rugi have appeared less free, thickened, often the entire mucosa looking much like granulation tissue.

These duodenal walls may be compared to the leg which has been the site of repeated varicose ulcerations or to one which has healed after being severely burned. Slight trauma which would go almost unnoticed on the normal leg will produce a stubborn ulcer. I believe we should quit thinking and saying "This patient's ulcer has become active again." It is in all probability not the same ulcer. He has a new ulcer in that chronically diseased duodenum. Part of this pathological condition is due to repeated ulceration and healing with deep scar tissue replacement. Multiple ulcers are not uncommonly observed. In one patient operated upon recently the probable location of two previous perforations could be seen and there was an active ulcer on the posterior wall. In ten cases of resection in which the patients had had free perforations an active ulcer was present posteriorly.

It is suggested that all of these individuals who cannot be maintained in reasonable health and comfort by the internist have such irreversible pathological changes in the duodenal wall, and especially over the pancreas, that the slightest exciting cause will produce an ulcer which can be healed only with great difficulty, if at all, and with further damage to the wall. I do not know why some reach this unfortunate state, but it is easy to see why they can find relief only at the hand of the surgeon. Appreciation of this existing condition is necessary to a wise choice of surgical procedure.

Since the internist has treated ulcer with such a high measure of success, we surgeons will do well to consider what he does and seek to emulate it. There are four local conditions which he considers and attacks more or less directly by various means.

* From the Department of Surgery, Wayne University College of Medicine. Read before the Central Surgical Association, Ann Arbor, February 28, 1941.

These conditions are (1) pylorospasm, (2) hypermotility, (3) hypersecretion, and (4) hyperacidity. (Fig. 1A.) If these can be that since these results must largely be obtained indirectly they are apt to be more or less incomplete. That this is true is

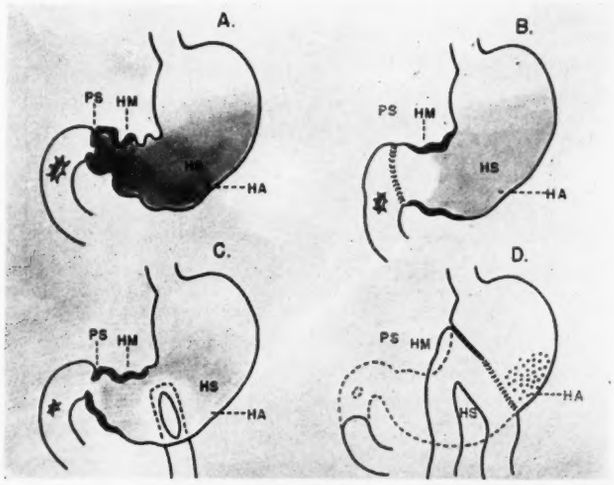


Fig. 1. PS, pylorospasm; HM, hypermotility; HS, hypersecretion; HA, hyperacidity. Depth of shading suggests degree of hyperacidity and hypersecretion. A, the stomach with active duodenal ulcer; B, after pyloroplasty; C, after gastrojejunostomy; D, after resection, which removes all factors.

continuously controlled, the ulcer usually heals and does not recur as long as this control is maintained.

How are these four treatment demands met by our standard operative procedures?

1. *Pyloroplasty* is a fairly commonly performed operation. (Fig. 1B.) This, it would seem, certainly once and for all eliminates pylorospasm by destroying the pyloric sphincter. One who has seen many stomachs, particularly under spinal anesthesia, has noted the spasm of the prepyloric area, and is justified in wondering just how much is actually accomplished by the average pyloroplasty. Finney and Horseley must have had this in mind when they devised their operations for both insisted that the incision be carried well up into the prepyloric portion of the stomach.

In addition to the elimination of pylorospasm, pyloroplasty is supposed to meet the other indications by permitting free back flow of alkaline duodenal contents to reduce acidity, and by the unobstructed wide opening which removes some of the reason for hypermotility as well as the effects of hypersecretion. It can be seen evidenced by the failure of pyloroplasty to cure the patient in too many cases. We have found ulcer recurring just a little further down beyond the old suture line.

In the presence of the duodenal pathological condition existing in these patients, it is an extremely optomistic surgeon who will expect this operation either to be satisfactorily performed or to give permanent relief.

If there is truth in the Edkin's hypothesis of an acid stimulating hormone in the antral mucosa, pyloroplasty leaves the patient no better off as far as his acid is concerned.

2. *Gastrojejunostomy* is supposed to eliminate vicariously the effects of pylorospasm as a result of the short circuit, and meet the other indications in much the same way as pyloroplasty, that is, by intragastric regurgitation and freer emptying. (Fig. 1C.) This again is an indirect means of attacking the problem. It is notoriously ineffective in the presence of high acidity and the absence of obstruction. Too often the patient is given a jejunal ulcer and his second state is worse than the first. He will

devoutly wish he had his duodenal ulcer back instead.

3. *High resection* completely eliminates all of these factors directly and permanently, and is, I believe, the only way in which most patients can be permanently cured. (Fig. 1D.) In the occasional case in which jejunal ulcer is reported following this operation, there is often doubt as to whether resection has been high enough. One should not be satisfied with removal of less than three-fourths of the stomach. All of our cases have been followed and no jejunal ulcer has occurred thus far.

Part of our duty is to improve our results individually and collectively. To this end I am confessing certain errors in technic and judgment. In forty-four resections for ulcer there were six deaths, a mortality rate of 13.6 per cent which is entirely too high. That we have profited by these mistakes is shown by the fact that in our last twenty-nine resections for all conditions there have been only two deaths,* one of which occurred in a man eighty years old with cancer.

The first death was due to breaking down of the anastomotic suture line. At that time only two rows of sutures were being used. Since then a third has been added and this disaster has not recurred. The VonPetz clamp has been of major value in facilitating high resections. The second death was due to poor judgment in attempting to do an exclusion after division just through the pyloric ring. The duodenal pathological condition described above was present and one should not expect it to hold. It did not hold. The next was somewhat similar in that not enough duodenal wall was separated from the pancreas to make closure of the stump secure. We have since learned to place a finger inside the duodenum as a guide when this dissection is difficult. Another fatal case presents an interesting question. There was a small fistula between the gallbladder and the duodenum. The gallbladder wall appeared quite normal and the opening in it was inverted and closed. It opened, a subdiaphragmatic abscess formed and was drained, but death occurred two months later from a liver abscess. If the gallbladder had been removed or drained or even had an exclusion been done, this patient would almost certainly be alive.

Two of the six deaths were caused by pulmonary complications, one on the seventh day due to pneumonia, the other on the thirtieth day due to multiple pulmonary abscesses following massive atalectasis. Both of these cases had intratracheal anesthesia. This method was used in eight of this series with seven major respiratory complications and three deaths. In one, however, the primary cause was abdominal and is described above. Intratracheal anesthesia has not been used since and no pulmonary deaths have occurred. I do not wish to decry the method which is invaluable in certain conditions, but in my hands it has been followed by a prohibitive rate of respiratory complications.

Twenty patients, or 45.4 per cent of this series, had had together twenty-seven previous operations for ulcer. There were twelve closures of acute perforations (two had had two), six gastrojejunostomies (one case had had two), three pyloroplasties, two degastroenterostomies, one antrumectomy, one excision of ulcer, one partial cholecystectomy and one exploration with appendectomy. Five of the six deaths occurred in this group.

There are seven resections for exclusion with one death referred to above. In the six recoveries the antral mucosa was not removed. All are clinically well, one after four years, the others for a shorter time. Three have shown no free acid after alcohol or histamine stimulation. We have not yet succeeded in getting determinations in the others. These results do not tend to support the Edkin's hypothesis, but the time following operation is admittedly too short for final conclusion. While we think the patient is safer with the pylorus and the first portion of the duodenum removed, when

* On January 7, 1942, forty-two consecutive resections for ulcer had been completed with one death.

the risk seems too great we shall probably continue to do an occasional resection for exclusion, adding, however, excision of the antral mucosa.

The operation has been completed with antecolic anastomosis without enteroenterostomy seventeen times. The patient who developed liver abscess is the only death in this group. In addition, seven have been done following resection for carcinoma. All have had good functional results, including the one who died two months later. The first one was done six years ago. *X*-ray studies in eight of them have shown no tendency toward stasis in the proximal loop. It has been hard for surgeons to get away from the idea that gravity plays an important rôle in the forward movement of intestinal contents. If the terminal ileum, cecum and ascending colon have no difficulty in transporting their load from the bottom of the pelvis to the hepatic flexure, why should we question the ability of the jejunum to do much less? In twenty-four cases the anterior anastomosis has functioned with complete satisfaction. It is simpler, easier, and therefore more quickly done. The difficulty of attaching the transverse mesocolon to the stump of the stomach after a high resection is eliminated, together with the possibility of proximal loop obstruction. Should subsequent operation be necessary the problem is much simpler. This was experienced in one patient who had had an antrumectomy and anterior anastomosis. We operated three years later for jejunal ulcer with much less difficulty than a posterior anastomosis would have caused. We believe at present that there are only three situations in which retrocolic anastomosis may be preferable: First, when resecting for jejunal ulcer following posterior gastrojejunostomy in which the opening in the transverse mesocolon is already present; second, when there is an unusually long transverse mesocolon, and third, when the jejunal mesentery is usually short. In some of the first the anterior method will be preferable.

Restoration of gastroduodenal continuity by some form of the Billroth 1 method has not been used in any cases of ulcer, though we have occasionally used it in cancer. The duodenal pathological condition increases the immediate operative risk as well as that of recurrence. The temptation must also be present to remove less of the stomach to facilitate the operation and prevent tension.

There still exists much difference of opinion as to the best plan for the surgical treatment of ulcer and also in detail of technic. I close by making a plea that results be reported frankly, the bad, which we hesitate to publish, as well as the good. Only in this way can we reach the goal of reasonably safe, permanently curative surgery in the ulcer patient.

SUMMARY

1. Extensive duodenitis is suggested as the reason some patients cannot be controlled on a medical régime.

2. The ability of standard operations to relieve pylorospasm, hypermotility, hypersecretion and hyperacidity, which is the aim of medical treatment, is discussed. Resection alone completely fulfils these requirements.

3. Errors in technic and judgment are described, correction of which has reduced the mortality rate.

4. Resection for exclusion has given good results and is recommended for those patients in whom complete resection carries too great a risk. The prepyloric mucosa should be removed.

5. Antecolic anastomosis without jejunojejunostomy is the method of choice in the majority of cases.

CONTINUOUS SPINAL ANESTHESIA*

REPORT OF ONE HUNDRED CASES IN WHICH THIS METHOD WAS EMPLOYED

F. PAUL ANSBRO, M.D. AND L. J. PICO, M.D.
Director of Anesthesiology, King's County Hospital
Associate Anesthetist, St. Peter's Hospital
BROOKLYN, NEW YORK

IN 1940, Dr. W. T. Lemmon, of Philadelphia, published his first work on spinal anesthesia by the continuous method. Research conducted on monkeys had shown him certain factors which he believed were true. The first of these factors was a new insight into the "fixation" of solutions. Lemmon demonstrated spinal anesthesia of a certain dose of one hour's duration in a monkey and then withdrawing the same amount of solution he had injected, he obtained the same length and degree of anesthesia in a second monkey after he had injected this dose into its subarachnoid space. He believed that only a small amount of the total injected solution in ordinary spinal anesthesia was being used and that the balance of this solution was not taken up by the nerves in the subarachnoid space until former fractions had been used up. The unused balance was idle until used and was subject to absorption by the circulation around the arachnoid which in turn produced the toxic effects often noted during "one injection" spinal anesthesia. He believed that a greater amount of the drug does not necessarily give a greater intensity of anesthesia, i.e., 500 mg. novocain does not give more intense anesthesia than 50 mg. over a given period of time.

The second factor was in the use of drugs. It is well known that the best drug for spinal anesthesia is novocain (ester of beta diethyl amino ethanol) based on its comparable low toxicity. Using toxicity of cocain as a standard of comparison (1) novocain is one-quarter as toxic, metycain three-quarters, pontocain three to five times more and nupercaine five times more toxic. The only disadvantage of novocain was its short duration of action. Pontocain and nupercaine were used in spite of their greater toxicity because of their prolonged action. By the continuous spinal method the disadvantage of novocain's short action is overcome as well as the possibility of producing toxic effects by injecting a greater amount of solution than can be utilized by the nervous tissue in the arachnoid in a given length of time.

Lemmon believed that the preanesthetic medication of the patient was as important as the anesthetic itself. He states: "must premedicate sufficiently: it is malpractice to do otherwise." The usual procedure we employ based on the age, weight, and metabolic activity of the patient is as follows:

The adult patient of 150 pounds and normal metabolism is given 3 gr. of pentabarbital sodium the night before operation and this is repeated the following morning three hours before operation. No patient who is to have a spinal anesthesia should be denied a barbiturate unless there is a very definite contraindication, such as a known idiosyncrasy. One outstanding property of the barbiturate in this field is its protection against toxic reactions from anesthetic drugs. It diminishes the risk, suppressing the convulsions, and the interference with the respiration by the cocain series of drugs. One hour before operation ⅓ gr. of pantopon is given. Pantopon is used in place of morphine sulfate because the incidence of nausea and vomiting during anesthesia is less with this drug than with morphine. It has also been found that pantopon produces a greater narcosis than

* From the Department of Anesthesia, St. Peter's Hospital, Brooklyn.

morphine. We combine scopolamine hydrobromide (levo-scopine tropate) with this opiate in the proportion of 25 to 1. The combination of pantopon and scopolamine in ratio of one to twenty-five has its maximum action in one and one-half hours and lasts three to five hours when effects on circulation, respiration and analgesia are considered. The variable results following injections of scopolamine can be explained by the fact that the commercial product contains four alkaloids: (a) A laevorotatory alkaloid which has a sedative and amnesic effect; (b) a dextrorotatory alkaloid which has a stimulant or excitant effect; (c and d) two isomeric alkaloids with variable effects.

It is, therefore, most important to be certain in premedication that the scopolamine used contains the pure laevorotatory alkaloid alone. Scopolamine is preferred to atropine because of its cerebral depressing action especially when used with an opiate. Secretions are dried about equally as well. During the course of the operation opiates are given, with or without scopolamine if the nervous state of the patient demands it. These drugs may be given intramuscularly or, if quick action is desired, intravenously; and the injections are repeated if necessary to produce the proper somnolent state of the patient which should obtain during spinal anesthesia.

Lemmon has developed special needles and tubing for his method. A special mattress is also in use. This mattress has a gap in the side for the accommodation of the needle. The needles are made of a special alloy which allows great malleability. No stylettes are used with them, but they have an extra opening on the side of the bevel to compensate somewhat for this disadvantage. All punctures are done in the lateral prone position and the usual interspace chosen is between the lumbar third or fourth. However, the interspace chosen does not bear the same relation to height of anesthesia in this method as in ordinary spinal anesthesia methods because you may get the solution higher by repeated barbotage and by forceful injections.

One per cent novocain with ¾ gr. of ephedrine are used for a skin wheal. A spinawl is then used to puncture the skin and the muscles of the vertebral column because the malleability of the needles is such that they cannot perforate these heavy barriers without danger of extreme angulation. A No. 18 needle is generally used and inserted through the puncture wound made by the spinawl. On reaching the dura a greater sense of resistance is felt here because of the comparable dullness of the malleable needle. The needle should be held short to prevent bending on insertion through the skin. On puncturing the dura a 10 cc. Luer-Lock syringe is attached to the needle and 10 cc. of spinal fluid is withdrawn. The spinal fluid is then mixed with the novocain to make the desired solution concentration. A 5 per cent solution is generally employed for upper abdominal work, a 3 per cent solution for lower abdominal work and a 1 or 2 per cent solution for breast or intrathoracic work. If an additional quantity of solution is desired, it may be made up either with distilled water or with spinal fluid which may be withdrawn through the syringe and mixed with more novocain. After the solution is made to the desired percentage the syringe containing it is connected to two feet of rubber tubing with a narrow lumen which just holds 2 cc. of solution. After filling the lumen of the tube it is connected to the needle in the spine and slight barbotage is effected to determine if there is a free flow between the subarachnoid space and the syringe. If the flow is free, a fractional amount is injected into the subarachnoid space, the patient returned to the supine position and kept flat for abdominal work and in the Trendelenburg position for chest work. After return to the supine position the flow is checked again to determine if it is free; if not, the needle is given a half-turn in an effort to do so. The flow of fluid from the subarachnoid space to the syringe must be free for best results of this method and to insure control of the anesthesia which is another advantage of the

method. The height of anesthesia is determined in the usual way by skin testing and one may effect a higher level by barbotage. As the operation proceeds fractional doses are added as needed (usually in 50 mg. amounts). Degrees of anesthesia as well as length of anesthesia are thus obtained. Just enough anesthetic agent (novocain) is added to produce the desired depth of anesthesia. Anesthesia is produced within two to eight minutes depending upon the height of anesthesia desired. Spinal fluid is absorbed and reformed six to seven times in twenty-four hours; hence, the novocain injected is fairly rapidly removed from the subarachnoid space and frequent replenishment is indicated. It has been found that 70 per cent of novocain disappears from free fluid in five minutes and only traces are present after thirty minutes. A moderate loss of fluid (20 to 25 cc.) will be replaced in one hour. Phenosulfophthalein injected into the subarachnoid space has appeared in the urine in twenty-five minutes.

It is to be emphasized that the term, "continuous," is misleading. "Fractional spinal anesthesia" would be more accurate. The term, "continuous," is productive of a concept of a long period of time whereas this method is adaptable to the shortest procedures as well as the longest. It is an unquestioned procedure in other modalities of anesthesia (inhalation of ether, intravenous barbiturates, etc.) in giving just sufficient amounts of the drug and no more or less to produce the desired depth of anesthesia.

It is logical that the same procedure of fractional dosage should be used in spinal anesthesia and this method offers the "modus operandi." In one of our cases a dose of 30 mg. of novocain was necessary for the surgical treatment of a fibroma of the leg which took a relatively short time to complete (twelve minutes). On the other hand, a radical breast amputation lasting three hours required 1,020 mg. of novocain.

OPERATIONS DONE UNDER CONTINUOUS SPINAL ANESTHESIA

Breast	1
Gastrointestinal	40
Biliary tract	15
Hernia	20
Gynecologic	15
Amputation	5
Orthopedic	5
Genitourinary	4
Total	105

CLASSIFICATION OF OPERATIONS

Radical Breast (1). The time during which the operation was performed lasted three hours and 1,020 mg. of novocain was used.

Gastrointestinal (40).

Abdominal perineal resections	5
Resection of cancer of colon and colostomy	3
Resection of cancer of cecum with lysis of adjacent adhesions	2
Intestinal exclusion with anastomosis of small intestines	2
Exploratory laparotomies	5
Appendectomies	20
Appendicitis with local peritonitis	3

The time during which the operation was performed lasted thirty-five minutes to three and one-half hours, using 75 to 430 mg. of novocain.

Biliary Tract (15). Exploratory Laparotomies (4).

Cancer of common duct with metastasis	2
Cancer of pancreas with metastasis	2

Cholecystectomies (11).

The time of operation was fifty minutes to two and one-half hours using 90 to 165 mg. of novocain.

Hernias (20).

Inguinal herniorrhaphies	8
Bilateral inguinal herniorrhaphies	7
Femoral herniorrhaphies	3
Scrotal herniorrhaphies	2

The time of operation was forty-five minutes to two hours using 75 to 165 mg. of novocain.

Gynecologic (15).

Pelvic	13
Vaginal	2

The time of operation was one to two hours using 99 to 160 mg. of novocain.

Amputations (5).

Lower Extremity	5

The time of operation was twenty-five minutes to one hour using 35 to 60 mg. of novocain.

Orthopedic (5).

Bone graft, for nonunion	5

The time of operation was one and one-half to two and one-half hours using 100 to 185 mg. of novocain.

Genitourinary (4).

Prostatectomy	3
Ureteral calculus	1

The time of operation was thirty minutes to two hours using 60 to 150 mg. of novocain.

All the operations were begun and completed under continuous spinal anesthesia.

COMPLICATIONS

The drop in blood pressure under continuous spinal anesthesia was notably less than in other methods of spinal anesthesia. This probably is due to the relatively small amount of solution injected into the subarachnoid space at one time. The degree of blood pressure fall is generally directly proportional to the number of white rami anesthetized. The primary fall of blood pressure is caused by the progressive upward paralysis of the white rami, beginning at the third lumbar segment. It is negligible until a number of segments above this have been involved. Hence, the smaller amount of free solution in the subarachnoid space, the less amount is available to anesthetize the rami. Our practice has been to give ¾ gr. of ephedrine before anesthesia if the systolic blood pressure is below 150 mm. of mercury. If above 150 mm. of mercury, we give the spinal injection first and the ephedrine a few minutes later. In only 3 per cent of our cases was it necessary to give additional ephedrine. The average variation of blood pressure was between 25 to 50 mm. of mercury.

The criteria for wearing off of the anesthesia are: (1) Intestines are less contracted; (2) abdominal muscular tone is regained; (3) patient complains of pain and discomfort; (4) a rise of blood pressure described by Dr. Lemmon as an indication of returning sensation was not constant in our series of cases.

If alarming toxic symptoms develop from injection of the novocain solution, one can with the fractional technic withdraw the cerebrospinal fluid (about 3 to 6 cc.) and it has been noted that the nerves recover promptly from the anesthesia. We have confirmed the above by withdrawing cerebrospinal fluid after operation in some of the cases while patients were unable to move their extremities under anesthesia and after withdrawal of cerebrospinal fluid the patients moved their extremities. Spinal anesthesia is maintained by the drug that is present in the cerebrospinal fluid; and when the concentration of the drug falls below a definite level, the analgesia promptly wears off.

In our series headache was an incident in only 2 per cent. The theory that post-spinal anesthesia headache is due either to spinal leakage or meningeal irritation is pretty well refuted when it is considered that the needle is left *in situ* for as long as three hours. One of the most frequent questions asked is about the possible harmful effects of the needle remaining in place during the operation. The low incidence of headaches absolves the indwelling needle from producing spinal leakage and meningismus. The incidence of infection of the skin, muscles or meninges was nil in our series, although in one case fecal material had collected about the needle and remained there for two hours due to the spilling of intestinal contents through a colostomy under the surgical drapes.

In our series of cases, the incidence of urinary retention was 4 per cent. There were three instances of pulmonary atelectasis making an incidence of 3 per cent. There were no transient palsies or permanent paralysis. There were no vertebral arthritis. In making a survey of the literature for fatality incidence, due to single dose spinal anesthesia, we have found the

following: During the periods of 1929 to 1936 there were 39,146 spinal anesthesias administered with 486 deaths or a fatality incidence of 2.2 per cent. Observations based on an experience of 13,136 spinal anesthesias carried out by the anesthetic staff of Toronto General Hospital during the periods 1930 to 1939, analysis reveals a death rate of 1 per cent. In a large series of 15,652 administrations of spinal anesthesia in eighteen American hospitals, the immediate mortality (on the table) was 40 or about 1:500. Although the report in the literature presents such a wide variation in fatality incidence, we believe that the fractional technic of spinal anesthesia is the answer to the above disadvantage and problem of spinal anesthesia.

SUMMARY AND CONCLUSIONS

A method of spinal anesthesia is presented which is considered to have definite advantages over "single dose" spinal anesthesia. The advantages are: (a) fractional injections; (b) controllability; (c) decreased toxicity; and (d) regulated duration of analgesia.

REFERENCES

Lemmon, William T. Continuous spinal anesthesia. *Ann. Surg.*, January, 1940.

Lemmon, William T. and Paschal, George W., Jr. Continuous spinal anesthesia. *Pennsylvania M. J.*, May, 1941.

Hand, Leo and Sise, L. F. Anesthesia for gastric surgery. *Surg. Clin. North America*, June, 1941.

Hewer, C. L. Recent Advances in Anesthesia and Analgesia. 3d ed. Philadelphia, 1937. P. Blakiston's Sons & Co.

Cunningham, Hugh A. Anesthesia. *Marquette M. Rev.*, June, 1940.

Maxson, L. H. Spinal Anesthesia. Philadelphia, 1938. J. B. Lippincott Co.

Adriani, John. The Pharmacology of Anesthetic Drugs, Springfield, Ill., 1940. Charles C. Thomas.

Babcock, W. W. Spinal Anesthesia. Cyclopedia of Medicine. Philadelphia, 1939. F. A. Davis Co.

Rovenstine, E. A. The preparation of patient for anesthesia. *J. Med.*, 1941.

Babcock, W. W. Survey of Spinal Anesthesia Deaths. Cyclopedia of Medicine. Philadelphia, 1939. F. A. Davis Co.

Ranson, S. W. Anatomy of the Nervous System. Philadelphia, 1923. W. B. Saunders Co.

Dogliotti, A. M. Anesthesia. Chicago, 1939. S. B. Debour.

Labat, Gaston. Regional Anesthesia. Its Technique and Clinical Application. Philadelphia, 1928. W. B. Saunders Co.

Howley, Thomas F. and Robertson, Jarrett P. Spinal anesthesia. *Am. J. Surg.*, 24: 129–133, 1934.

Sellman, Priscilla. Nausea and vomiting during spinal anesthesia. *Anesthesiology*, 2: 333–338, 1941.

SUPRAPUBIC TROCAR DRAINAGE OF THE BLADDER*

GEORGE AUSTEN, JR., M.D.
Assistant Resident in Surgery, Peter Bent Brigham Hospital
BOSTON, MASSACHUSETTS

COMPLETE or partial retention of urine in man is a frequent complication of benign hyperplasia and of carcinoma of the prostate. In these patients the ultimate goal of therapy is, of course, the eventual removal of the obstructing prostate gland. However, the presence of urinary retention, whether acute or chronic, generally necessitates a preliminary period of treatment during which efforts must be directed principally toward (1) adequate drainage of the distended bladder, and (2) the prevention or control of infection of the urinary tract. A review of a group of patients who entered the Peter Bent Brigham Hospital with prostatic disease and urinary retention served to emphasize certain fundamental facts regarding these problems. As would be suspected, because of the age and poor general condition of the patients for whom suprapubic cystotomy was necessary, the morbidity and mortality in this group was higher than that in the group of prostatic patients in whom only drainage by catheter was needed. Yet a study of this latter group revealed that preoperative and postoperative complications of the urogenital tract were not infrequent, were often of a serious nature and occasionally terminated in death. This was particularly true in cases in which the constant indwelling catheter had been employed. After making a more detailed review of patients in this group who had such complications, it was evident that in all cases in which the outcome was unfavorable, there was only one constant finding, namely, every patient ran a septic course due to urinary infection, and in every instance this was apparently inaugurated or at least aggravated by some form of urethral instrumentation.

Although the use of the urethral catheter has been recognized as an indispensable means of treatment in many cases of obstruction of the bladder neck it has long been believed that it is not the ideal form of drainage. It is now known that the normal male urethra harbors certain bacterial organisms, principally the micrococcus and alpha streptococcus. As a result of the presence of a catheter in the urethra, with its attendant trauma, the growth of these organisms may be so promoted that there is initiated an active inflammatory process which may involve not only the urethra but also the bladder, and even one or both kidneys. Moreover, should a urinary infection exist before instrumentation, the employment of intermittent or continuous catheterization may serve only to intensify it. Any such infection is a grave detriment to the satisfactory progress of these patients, particularly so when it occurs in individuals of an age group frequently suffering from generalized arteriosclerosis, myocardial disease, hypertension, diabetes, etc. Its control, even with the use of the newer chemotherapeutic agents, may be extremely difficult. There are other drawbacks to the use of the urethral catheter which often contraindicate its employment. The channel of the urethra may be so distorted by the obstructing prostate that a catheter cannot be introduced through it into the bladder; or once introduced, its presence may be intolerable. Also, in occasional instances, drainage by this means may be incomplete and inadequate.

* From the Urological Clinic of the Peter Bent Brigham Hospital and the Laboratory for Surgical Research of the Harvard Medical School, Boston, Massachusetts.

Recognizing the premise that the best surgical care of these patients is dependent upon prevention and elimination of infection, and aware of the disadvantages of the urethral catheter, it seemed that some method of drainage other than the urethral catheter should be instituted for the majority of patients preliminary to operation. Since open suprapubic cystotomy was thought to be definitely undesirable for routine use, we have adopted still another means of drainage which, in our hands, has been found more satisfactory than either the inlying catheter or suprapubic cystotomy. This consists of suprapubic puncture of the bladder by trocar and cannula through the prevesical space. An analysis of thirty-two consecutive cases in which the patients were so treated during the past two years is presented in this paper.

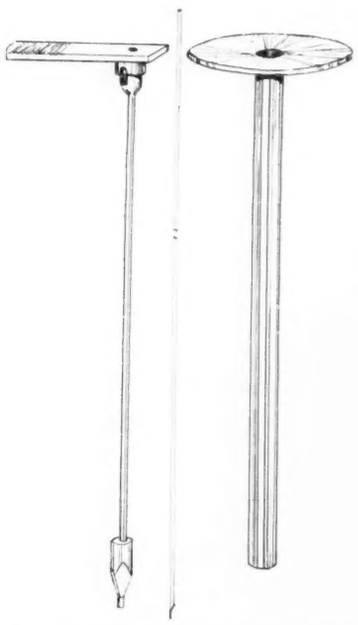


Fig. 1. Trocar, cannula and long needle for suprapubic puncture.

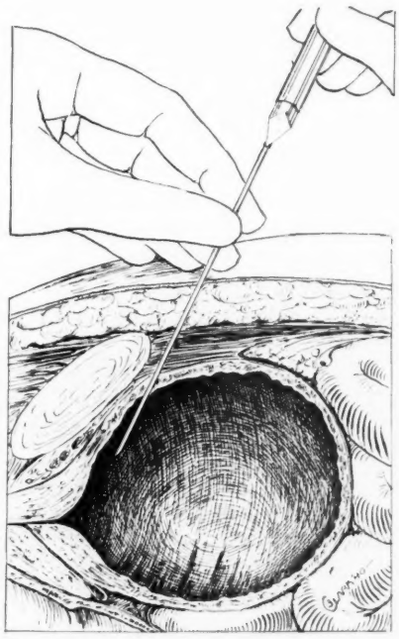


Fig. 2. Cross section of pelvis to illustrate direction of insertion of needle and manner in which trocar and cannula are threaded over needle after its entrance into the bladder.

Suprapubic puncture of the bladder using a trocar and catheter has been employed occasionally for many years, but in the hands of those unaccustomed to the procedure it has been used with some hesitancy because of the assumed danger of perforating the peritoneum or a loop of bowel. It has been said that even with complete distention of the bladder, the depth to which the peritoneal fold descends with relation to the symphysis pubis, is so variable as to make such puncture of the bladder unsafe. In the past two years, however, we have carried out this procedure many times, and as long as the bladder is tensely filled and palpable above the symphysis, we are certain of its safety and efficacy. It is a procedure which can be carried out in a few minutes, and with adequate premedication is attended by little pain. If the bladder is not palpable above the symphysis, a urethral catheter should first be introduced and the bladder filled to capacity before the trocar is used.

Various types of trocars, as found in the usual surgical armamentarium, are applicable for suprapubic puncture. The majority of these are of a size which will admit only a No. 14 to No. 16 French soft rubber catheter. The instrument which we have more commonly used, because of its slightly larger calibre and added safety,

is the one devised by Kreutzmann.* This consists of a special needle No. 22 wire gauge and the usual trocar and cannula, the latter (No. 22 French) sufficient to admit a No. 18 French catheter. (Fig. 1.)

TECHNIC OF PUNCTURE

The technic of suprapubic puncture by this instrument is as follows: The suprapubic region is sterilized as for a cystotomy. Under local infiltration anesthesia, a small vertical incision, ½ to 1 cm. in length, is made through the skin and fascia in the midline just above the symphysis pubis. The long needle is plunged inward and downward through this opening, passing just above and behind the symphysis. (Fig. 2.) When the bladder is entered, urine immediately trickles out of the needle. Should the intestine be perforated, gas will escape from the needle, but the very small puncture wound so caused is not sufficient to produce leakage and peritonitis. The trocar and cannula are then passed over the needle, and with slight rotary pressure the entire instrument enters the bladder guided by the needle. The trocar and needle are then removed, and a No. 18 French soft rubber graduated catheter is immediately passed through the cannula into the bladder. The cannula is then withdrawn, leaving the catheter in place. (Fig. 3.) A single silk suture passing through the skin edge and the wall of the catheter fixes the latter securely in place. A sterile dressing is applied and the catheter is connected to a sterile drainage system. Drainage is best when the tip of the catheter in the bladder lies approximately 12 cm. from the skin surface. At this level, cystoscopic examination shows the intravesical end of the tube to be above the bladder outlet and just resting on the trigone when the bladder is slightly or moderately distended. Drainage is also improved by cutting several extra holes at the intravesical end of the catheter.

* Kreutzmann, H. A. R. An improved suprapubic trocar and cannula. *J. Urol.*, 40: 341, 1938.

In the present series of thirty-two patients, twenty-nine had benign hyperplasia of the prostate, while in three instances the prostate contained carcinoma. Of the former group, twenty-two were free of other serious genitourinary tract complications, while one had an acute prostatitis, two had urethral stricture, two had acute and chronic pyelonephritis, one had a carcinoma of the rectosigmoid with local metastases and one had several vesical calculi. Of the three patients showing prostatic malignancy, one had no demonstrable metastases but moderately advanced local extension of the growth, while the other two had roentgenographic evidence of metastasis to the spine and pelvis. The average age of the patients with benign hypertrophy was sixty-seven years and of those with carcinoma sixty-four years. The average duration of symptoms in the former group was 4.7 years, and in the latter group 1.8 years.

Twenty-three patients entered the hospital with acute urinary retention, while nine patients had chronic retention of varying degree. (Table 1.) A number of the former group gave a history of chronic retention of variable duration preceding the attack of complete obstruction. In the majority of cases with acute retention, no definite causative factor preceding this event could be determined, but in others some form of urethral instrumentation, either for diagnostic or therapeutic purposes appeared to have initiated this outcome. In one instance, a diagnostic cystoscopy was followed by total obstruction and signs of an acute urinary infection which required hospitalization.

Of the entire group of thirty-two patients, there were twenty-seven upon whom some form of urethral instrumentation had been performed prior to admission to the hospital. A history of fever and chills preceding entry was obtained in ten patients; and in every instance the symptoms of infection were inaugurated by undue urethral trauma attendant upon attempted relief of obstruction or upon some otherwise

simple diagnostic procedure. Examination of these patients showed pus and bacteria in the urine. Cultures from the urethra were

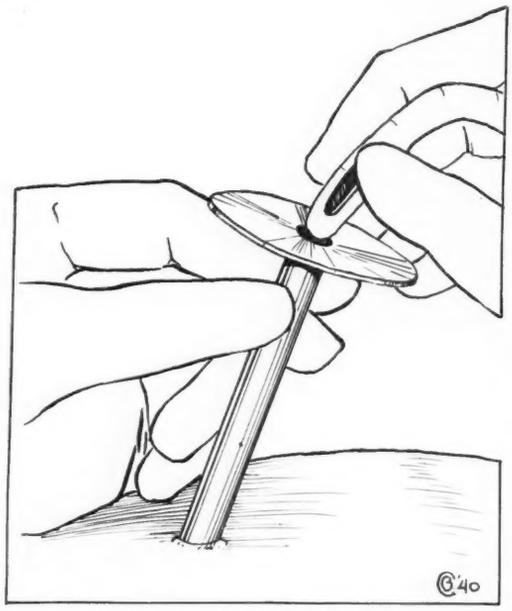


Fig. 3. Cannula in bladder and trocar removed, soft rubber catheter passed through cannula into bladder.

taken in many of these cases, and in approximately 40 per cent the organisms grown from the urethra and bladder were identical. It is of further interest to note that of the entire group, only four patients had a sterile bladder, and these were patients upon whom previous instrumentation had not been performed. This fact emphasizes the danger attendant upon urethral instrumentation of any patient having acute or chronic urinary retention.

In the majority of the cases, suprapubic trocar drainage was instituted soon after admission to the hospital and before any further urethral catheterizations were attempted. During the early part of this study, however, this form of procedure was not always followed; thus in five cases drainage was first obtained either by intermittent or constant urethral catheterization. But in every case trocar drainage was later instituted: in two instances because of the development of an acute urethritis, in one because of a rising fever and signs of acute urinary infection, in another because of intolerance to the inlying catheter, and in the fifth case because a prolonged period of preoperative drainage was necessary and the patient was considered too poor a risk even for open suprapubic cystotomy. Bilateral vasectomy was usually done at the time of trocar drainage or during the period of drainage prior to operation.

Excluding the three patients with malignant disease of the prostate, all of whom were inoperable from the standpoint of a possible cure, there were in the remaining group of twenty-nine patients three poor risk cases. These were elderly patients who entered the hospital in a moribund condition, two in a state of coma, and all three showing signs of moderate or marked cardiac failure. In each case repeated urethral instrumentation had been carried out before admission to the hospital and on entry there was evidence of extensive urinary tract infection. Immediate suprapubic trocar puncture was performed and adequate drainage obtained. However, one patient died soon after entry with signs of cardiac and renal failure, while the other two, although improving sufficiently to undergo transurethral resection, died of bronchopneumonia and cardiac failure following operation. Death in each instance was due to factors not attributable to urinary sepsis or lack of adequate drainage.

Excluding these three patients who were poor risks, but including the three patients with malignant disease, there remain for study twenty-nine cases. In this group there were no preoperative deaths. The morbidity rate was correspondingly low and represents a distinct improvement as compared to that in a preceding series of patients with obstructing prostates who were drained with the urethral catheter. Following the trocar puncture and insertion of a catheter, there generally occurred a slight rise in temperature to 99° or 100°F. for twenty-four to forty-eight hours, following which the temperature returned to normal and remained so thereafter. Many patients showed no febrile reaction at all

after this procedure, while several others had a somewhat sharper elevation of temperature than usual to 101° or 102°F., but in such instances a normal level was again reached within three to four days. Of the group of patients who entered the hospital with a history of preceding fever and chills following urethral instrumentation, several of whom had been on inlying catheter drainage for varying periods of time, all showed a surprisingly prompt return of the temperature to normal after the institution of suprapubic trocar drainage. There was almost complete relief of bladder symptoms in all except a few, and these became asymptomatic following proper adjustment of the catheter or after local treatment of a previously existing urethritis or prostatitis. In contrast to the rather frequent occurrence of epididymitis which is seen during the course of preoperative drainage by urethral catheter, it is noteworthy that this complication was not observed in the present series of cases.

TABLE I

	No. of Cases	Average Age, Yrs.	Average Duration of Symptoms, Yrs.	Retention		Previous Instrumentation		Blood Nonprotein Nitrogen			
								Before Trocar		After Trocar	
				Acute	Chronic	Yes	No	Elevated	Normal	Elevated	Normal
Benign hypertrophy	29	67	4.7	20	9	25	4	12	17	3*	26
Carcinoma	3	64	1.8	3	0	2	1	1	2	0	3

* In 2 cases, NPN dropped from above 150 mg. per 100 cc. before drainage to 50–75 mg. per 100 cc. after drainage, at which range it remained constant. In 3rd case, NPN rose progressively above 120 mg. per 100 cc. and patient died of cardiac and renal failure on the third day after drainage.

TABLE II

	Urinary Infection on Entry		Diminution in No. of Pus Cells in Urine after Trocar		Urine Culture before Trocar			Urine Culture after Trocar		
	Yes	No	Yes	No	Pos.	Neg.	Not Taken	Pos.	Neg.	Not Taken
Benign hypertrophy	+ 12 ++ 7 +++ 6	4	21	8	14	3	12	15	1	13
Carcinoma	+ 2 ++ 1 +++ 0	0	3	0	1	..	2	2	..	1

As will be seen from Table II, there was relatively little change in the bacteriological characteristics of the urine after suprapubic trocar drainage. Those patients who showed a growth of organisms in the urine before this form of drainage was instituted continued to do so after drainage but to a less marked degree. The number of pus cells, however, was definitely diminished in over 70 per cent of the cases, and in the majority of those whose urine re-

mained unchanged, some focus of infection elsewhere in the urinary tract, usually the kidney, was accountable for the persistent pyuria. On the whole, the urine of patients drained in this manner remained clearer than that of patients who had had urethral catheter drainage; and in contrast to the marked cystitis so often observed in the latter group, the bladders in these patients were relatively free of inflammation. There was generally some infection and bullous edema on the floor of the bladder where the tip of the catheter rested, but the mucosa elsewhere was quite clear.

The duration of preoperative drainage varied between six and twenty days, the minimum being two days, the maximum being one hundred thirty-five days. In those instances in which prolonged drainage was necessary, no difficulty was encountered in changing the catheter whenever deemed advisable, since a well formed sinus tract had usually been established by the end of two weeks. No serious complications attributable to suprapubic puncture drainage were observed during the course of this study, although there were several minor complications of interest. These were the result of inexpert use of the trocar, for in each instance the puncture was carried out by a junior intern who was performing this procedure for the first time and had difficulty with the proper insertion of the trocar; this undoubtedly caused considerable trauma to the perivesical tissues. One patient developed a prevesical abscess on the tenth day of drainage for which suprapubic cystotomy and drainage of the abscess were performed, later followed by an uneventful suprapubic prostatectomy. Another patient had a chill and abrupt elevation of temperature four hours after suprapubic puncture and within twelve hours developed marked lower abdominal pain, tenderness and muscle spasm. Although drainage of urine appeared to be adequate, it was believed that possible perforation of the peritoneum might have occurred, and accordingly, open cystotomy was done. At operation no tear in the peritoneum or bowel was found; the perivesical tissues appeared normal. The patient's symptoms and signs subsided immediately after the institution of open drainage. He later underwent prostatic enucleation without event and made a good recovery.

Prostatectomy, either enucleation or resection, was performed in all except two of the thirty-two cases. One man with advanced carcinoma of the prostate, who entered the hospital because of acute retention, was discharged without operation and died several weeks later of malignancy. A second man, previously mentioned, died of uremia and cardiac failure on the fourth day after the establishment of trocar drainage. In the remaining group of thirty patients, there were two deaths following operation, both occurring in patients who were bad risks. The operative mortality for the entire series was thus 6.6 per cent; while if the poor risk patients are eliminated, the operative mortality was 0 per cent. In the majority of cases, convalescence following operation was quite smooth and complications were infrequent. Bilateral epididymitis occurred in two instances, moderate urethritis in four instances following perineal prostatectomy, and prostatic bed infection in two instances following transurethral resection.

Follow-up studies were obtained in nineteen of the thirty-two cases. There were twelve patients who showed a clear, sterile urine within three to six months after discharge from the hospital. The urine in four others still contained a few leucocytes at the end of this time, but cultures of the urine were negative in two of this group. Two patients who had chronic pyelonephritis still showed a moderate pyuria two and four months after operation, respectively, while one man was readmitted to the hospital six weeks after operation having a staphylococcus bacteremia which terminated in death. The urine in this case contained many pus cells and showed a heavy growth of Bacillus coli and Staphylococcus aureus on culture

In all patients whom we were able to examine postoperatively, there remained little or no evidence of residual obstruction at the bladder neck. The suprapubic puncture wounds, which had closed within six to twelve hours after removal of the catheter, were well healed and without signs of infection.

Since adopting the use of suprapubic trocar drainage for the preoperative preparation of a majority of our patients with obstructing prostates, we have also carried out this procedure in instances of acute and chronic urinary retention due to other causes, particularly in certain cases in which urethral instrumentation is contraindicated due to adjacent infection. It has been performed once for retention due to a prostatic abscess, twice for obstruction due to impermeable urethral strictures and once for chronic retention in a patient with a cord bladder. In each instance the subsequent course of the patient has confirmed the efficacy of this method of treatment, signs of infection rapidly subsiding and no complications occurring during the following period of local therapy.

SUMMARY

A review of our cases of urinary obstruction due to prostatism, in which urethral catheter drainage had been used as a means of preliminary preparation for operation, revealed that the preoperative morbidity and mortality in patients who were otherwise good risks was relatively high, and that complications were not infrequent. Further study of this group showed that these undesirable occurrences were directly attributable to urinary sepsis, and that in every instance this was introduced or accentuated by some form of urethral instrumentation. For this reason we believed that a method of drainage other than the urethral catheter should be used, and therefore in the past two years we have substituted suprapubic trocar drainage for such patients.

A series of thirty-two cases of patients with urinary retention due to benign hypertrophy and carcinoma of the prostate treated in this manner has been reviewed, and the results of this study analyzed.

By this method of preoperative preparation, the routine care of patients with obstruction of the bladder outlet is greatly facilitated, the urinary tract infection which accompanies urethral drainage is largely eliminated, excellent decompression of the bladder can be maintained without the subjective discomfort so often attendant upon an inlying urethral catheter and complications are infrequent.

As a result of our experience, we believe that suprapubic trocar drainage of the bladder is an entirely safe procedure, and that its use in acute and chronic urinary retention due to prostatic obstruction has substantially reduced the preoperative and postoperative morbidity and mortality of this disease.

PROCTOLOGY IN GENERAL OFFICE PRACTICE

ROBERT TURELL, M.D.
NEW YORK, NEW YORK

THE extent to which the general practitioner may attempt to treat proctologic disorders will depend on his surgical training, ability, aptitude and knowledge. Dexterity in the use of the simple proctologic armamentarium and a knowledge of the correct interpretation of the various findings are essential; these can only be gained from actual experience.

Inspection of the perineum and circumanal area reveals the presence or absence of external hemorrhoids, tabs, anal fissures or ulcers, perianal cutaneous changes and discharges from the anal orifice. Digital examination elicits spasm of the anal sphincter muscles, tenderness, induration and neoplasm. Bidigital examination (the index finger in the anal canal and thumb on the perianal area) will frequently localize tender areas and give a clue to hidden suppurations in the perianal tissues. Every patient with anorectal complaints or disease should have a sigmoidoscopic examination. This examination is especially important in the visualization of the ampulla for here roentgenologic examination is unreliable. Anoproctosigmoidoscopic examination is best performed in the inverted position; it may, however, be carried out successfully in other positions, such as in the Sims. In this examination the terminal 25 cm. of the bowel can be directly visualized and material for microscopic study may be obtained. The roentgenologic examination of the colon with the aid of barium sulfate should be carried out in every case with a questionable diagnosis or where concomitant disease of the colon is suspected.

The discharges from the anal orifice should be stained with Gram and Ziehl-Neelsen stains. The stool may be examined in the office for ova, cysts, parasites and occult blood. In suspected cases scrapings of the mucosa or from the surface of an ulcer should be adequately studied for amebae and cysts; these scrapings also constitute good material for culture of enteric organisms. Neoplasms (and ulcers on occasion) should be biopsied.

RECTAL BLEEDING

Rectal bleeding is a common but most neglected complaint and calls for a systematic and thorough examination. Internal hemorrhoids are the most frequent cause while neoplasm is the most important. Rarely, bleeding in children may originate from an ulceration of aberrant gastric mucosa in the rectum.[1] Blood dyscrasias and vitamin C and K deficiencies may cause occult or gross bleeding from the colon and rectum. Bleeding noted in diarrheas is frequently an expression of subclinical hypovitaminosis.[2]

PRURITUS ANI

The etiology and the treatment of this condition are still poorly understood; a comprehensive study requiring the services of several specialists is at times necessary. Rigid cleanliness is very essential. Lilienthal's method of applying bland ointments to the perianal region prior to defecation prevents fecal soiling and is effective in many cases.[3] For topical application, gentian violet dissolved in water or alcohol and Castellani's carbolfuchsin solution with or without menthol appear to be the most effective drugs. The injection of the oil soluble long acting anesthetics into the perianal tissues has resulted in a permanent cure in a few and in temporary relief in many cases. Concomitant anorectal lesions should be extirpated in all cases of pruritus ani regardless of their etiologic importance in pruritus. The intractable cases of pruritus ani may be treated by the perianal

injection of alcohol or by the tattooing of the anal canal and the perianal region with mercury sulfide. To date, tattooing with mercury sulfide has yielded most encouraging results.[4]

HEMORRHOIDS

Perianal hematomas (thrombosed external piles) may be treated conservatively with external heat, or by operation, if pain continues in spite of conservative treatment. Mixed (internal and external) piles should be removed surgically. The operation of choice is a nontraumatizing procedure that will remove the varices as well as the sources and channels of infection and provide ample drainage through the open wounds. The incisions are made in the long axis to the rectum and anal tube and are carried to the perianal skin in a radial manner. Strangulated internal piles are treated either by immediate operation or by palliative measures and deferred surgery. The author prefers immediate operation combined with the administration of sulfonamides.

Uncomplicated, soft, bleeding, prolapsing and spontaneously reducible internal hemorrhoids are suitable for injectional therapy. The main purpose of this form of treatment is to stop bleeding and to correct the associated prolapse. Recurrences are dependent on the fate of the fibrosis produced and on the elimination of the etiologic factors which had existed prior to the institution of injectional therapy. The contraindications to injection treatment include the presence of mixed piles, recent or old inflammation or infection, neoplastic disease in the anorectocolonic tube or other concomitant local lesions requiring surgical treatment. The technics of injection vary with the experience of the operator. I prefer to make weekly submucous injections about the pedicle of the hemorrhoid above the anorectal ring thus obliterating the hemorrhoidal vein of each internal pile and fixing the mucosa at a high level to prevent prolapse. Subsequently, weekly injections are made into the hemorrhoidal masses at a lower level. I usually employ a 5 per cent solution of quinine and urea hydrochloride. (Recently, I have been studying the efficacy and effects of sodium psylliate.) The injectional method of treatment is neither simple nor without danger; it has definite limitations which should be understood lest disappointments and complications result.

ANAL FISSURES (ULCERS)

The acute fissure is superficial and without adjacent inflammation or induration. It either heals spontaneously or by the topical application of bland ointments. Occasionally, the long acting soluble anesthetics are used to allay pain.

The chronic fissure is an ulcer with adjacent induration and inflammation and is accompanied by dysfunction and fibrosis of the subcutaneous portion of the external anal sphincter muscle. This lesion is best treated by wide excision of the ulcer bearing area including the involved crypt or crypts (and the sentinel pile, if present) followed by the division of the subcutaneous component of the external anal sphincter muscle. The use of the long acting oil soluble anesthetics for the treatment of this lesion is dangerous and ineffective. The operation is effective and safe and is preferable to the taking of even the slightest risk with the injection of the slow absorbing anesthetic solution.[5]

ANAL ABSCESS AND ANAL FISTULA

Perianal abscess usually originates in an infection of a crypt of Morgagni and anal ducts and may eventually result in an anal fistula. The anal ducts empty into the crypts but lead to racemose anal glands situated in the perianal tissues and may pierce the anal sphincter muscles. Anal and perianal abscesses should be incised and drained adequately at the earliest opportunity. For the radical cure of fistula-in-ano, the entire tract and the surrounding infected granulation tissue should be excised followed by light packing of the wound with plain or iodoform gauze.

Of equal importance is the correct and meticulous postoperative care. Anal incontinence may follow an incorrectly performed fistulectomy; it is almost always a "product of unforgivable incompetence."[6]

POLYPS

Small islets of hyperplasia of the epithelium of the rectum and sigmoid are believed to be precursors of polyps.[7] The great clinical significance of polypoid disease lies in its frequency of progression to malignancy. Occasionally, polyps associated with ulcerative colitis may undergo adenomatous or malignant changes.[8] Polyps and the islets of hyperplasia are best destroyed by fulguration. This procedure is not without risk even in the hands of the experts. Polyps occurring below the reflection of the peritoneum may be treated in the office; those occurring above the peritoneal reflection should be treated in a hospital. Polyps of the colon situated beyond the safe reach of the sigmoidoscope should be extirpated through a transcolonic procedure.[9]

STRICTURE

Benign rectal strictures are either of traumatic, operative or inflammatory origin. The last type is most frequently produced by venereal lymphogranuloma. These rectal strictures may be diaphragmatic or tubular in character. Strictures and other rectal complications (proctitis, suppurations, fistula-in-ano, etc.) are the result of the spread of the virus from the genital tract to the pararectal glands producing perirectal infection and fibrosis. A positive intracutaneous Frei test usually establishes the diagnosis of venereal lymphogranuloma. However, the isolation of the virus in the bowel discharges or tissues constitutes positive proof that the virus is the cause of the intestinal lesion. The sulfonamides or Frei antigen are effective therapeutic agents exerting beneficial systemic and local effects.[10,11] Since the institution of chemotherapy, surgical treatment of the anorectocolonic manifestations of venereal lymphogranuloma has been largely limited to incision and drainage of localized perianal and perirectal suppurations, to the performance of an occasional temporary colostomy for acute obstruction and to the digital or instrumental dilatation of the fibrous stricture.

ANAL GONORRHEA

It is known that gonococci may remain alive and virulent for years in the anal structures and that reinfection of the genital tract may result from the anal focus. Suitable biologic conditions for the acquisition and maintenance of gonorrheal infection are furnished by the transitional epithelium of the intermediate zone of the anal canal, the anal ducts and the crypts of Morgagni. Sulfanilamide or its derivatives administered orally is effective against anal gonorrhea in the absence of localized suppurations or poorly draining sinuses.[12]

ANORECTAL TUBERCULOSIS

In many cases a diagnosis of anorectal tuberculosis can be made clinically by the characteristic appearance of the anal lesions. The presence of tuberculosis in the anorectal granulation tissues on histologic examination is an essential criterion for the diagnosis of a tuberculous anal lesion in the patient with pulmonary tuberculosis who has a positive sputum.[13] These patients may harbor viable and virulent tubercle bacilli in the terminal bowel, hence the finding of the tubercle bacillus by culture or animal inoculation is not significant in the study of their anal lesions. In contrast, the cultures and animal inoculation are conclusive in the study of anorectal lesions of patients with pulmonary tuberculosis who have negative sputa. The cure of the tuberculous anorectal lesion demands radical surgical extirpation and meticulous postoperative care. Healing is complete following proper surgical therapy that is augmented by measures aiming to improve the general health of the patient.

PEDIATRIC PROCTOLOGY

The indications for proctosigmoidoscopic examination of infants and children are the same as those for adults. Juveniles, like adults, are subject to inflammatory bacterial or parasitic disease, suppurations, fistulas and fissure-in-ano, prolapse of the rectum, benign and malignant polyps and other tumors. Unlike adults, infants and young children seldom have internal piles but more often show congenital malformations of the anus and rectum.

AMBULATORY OPERATIVE TREATMENT

Perianal hematoma (external thrombosed pile), subacute fissures and short subcutaneous sinuses or fistulas are suitable for ambulatory operative treatment.[14] Those performing ambulatory operations for anorectal lesions must provide office facilities for immediate postoperative rest and care, and proper supervision at the patient's home. It is generally admitted that ambulatory surgical treatment of anorectal disorders is usually incomplete in scope and only palliative in character. It can hardly be gainsaid that better results follow operations performed in a hospital.[15]

SUMMARY

Salient features of diagnosis and treatment of anorectal diseases are briefly presented to serve as a guide to those who do not specialize in proctology. Established principles and procedures are re-emphasized and new and important facts, such as chemotherapy for anorectal manifestations of venereal lymphogranuloma and uncomplicated anal gonorrhea, and tattooing of the anal and perianal areas with mercury sulfide for intractable pernicious pruritus ani, are discussed.

REFERENCES

1. Fleet, G. A. Misplaced gastric mucosa as a cause of massive rectal hemorrhage. *Canad. M. A. J.*, 42: 216, 1940.
2. Mackie, T. T. Vitamin deficiencies in gastrointestinal disease. *Ann. Int. Med.*, 14: 28, 1940.
3. Lilienthal, H. Pruritus ani. *J. A. M. A.*, 110: 509, 1938.
4. Turell, R. Tattooing (puncturation) with mercury sulfide and other chemicals for treatment of pruritus ani and perinei: further investigations. *J. Invest. Dermat.*, 3: 289, 1940.
5. Wass, S. H. Painful affections of anal canal. *Guy's Hosp. Gaz.*, 54: 110, 1940.
6. Blaisdell, P. C. Pathogenesis of anal fissure and implications as to treatment. *Surg., Gynec. & Obst.*, 65: 672, 1937.
7. Martin, W. J., Jr. Polypoid versus carcinomatous lesions of colon and rectum. *South. M. J.*, 33: 428, 1940.
8. Coffey, R. J. and Bargen, J. A. Intestinal polyps: pathogenesis and relation to malignancy. *Surg., Gynec. & Obst.*, 69: 136, 1939.
9. Cattell, R. B. and Swinton, N. W. Diagnosis and treatment of sigmoidal polyps. *New England J. Med.*, 222: 535, 1940.
10. Marino, A. W. M., Turell, R., Buda, A. M. and Nerb, L. Treatment of venereal lymphogranuloma with sulfanilamide. *Am. J. Surg.*, 46: 343, 1939.
11. Kornblith, B. A. Lymphogranuloma venereum. *Am. J. M. Sc.*, 198: 231, 1939.
12. Turell, R. Sulfanilamide in treatment of gonorrhea of anal canal. *J. Lab. & Clin. Med.*, in press.
13. Martin, C. L. and Sweany, H. C. Tuberculous anal abscess and fistula criteria for diagnosis. *Surg., Gynec. & Obst.*, 71: 294, 1940.
14. Anderson, J. K. Office treatment of rectal and anal pathology. *Nebraska M. J.*, 24: 441, 1939.
15. Jeurink, V. G. Office treatment of common rectal disorders. *Rocky Mountain M. J.*, 36: 629, 1939.

PERIPHERAL VASCULAR SURGERY*

LESSONS FROM SIX YEARS' EXPERIENCE

F. M. Al Akl, M.D.,
Alexander Singer, M.D. and C. Burling Roesch, M.D.
BROOKLYN, NEW YORK

THE present trend toward a reclassification of gangrene in the lower extremity is most timely. Because of the misleading implications of the older classification, this change will be welcomed by the clinician when confronted with the question of what and how much to do. The newer concept of the pathological processes involved and the tremendous improvement in our therapeutic measures for regulating the patient's metabolism have practically eliminated diabetes as an immediate factor in handling gangrene. The former division of necrotic lesions of the lower extremity into diabetic and arteriosclerotic has, therefore, lost its significance and has become more confusing to the clinician than helpful.

The pathological problem presented in a lesion of a toe or a foot resolves itself, as has frequently been emphasized, into one of inadequate arteriation, one of infection or a combination of both, with or without the metabolic derangement known as diabetes mellitus. The newer classification of these lesions into vascular, infectious or mixed is more to the point and much sounder because of its contribution toward a saner therapeutic approach. The classification heretofore employed, perhaps to impress the surgeon with the old adage of not to temporize with infection in a diabetic patient for fear of rapid spreading and not to deal conservatively with an extremity affected with necrosis in the presence of diabetes, because sooner or later the extremity has to come to major amputation, is not workable any more; and while a number of extremities with even little evidence of necrosis come eventually to total amputation, the reason is not diabetes, but rather that many of these lesions are due to infection preying upon a limb devitalized by an already impoverished circulation whatever the primary cause.

When the use of insulin first became popular some fifteen years ago, a wave of conservatism and watchful waiting for developments in surgical lesions in diabetic patients came into vogue. The hope was that an attempt at controlling the metabolic status might rally enough of the patient's forces of resistance to arrest the spreading pathological process and effect a localization, making the lesion an easier target for surgical attack. The often resultant prolonged morbidity, however, sapping both the vitality and morale of the patient and resulting in a higher mortality of secondary and delayed primary operations, has caused a revolt against conservative surgery, and a swinging of the pendulum back toward the ultra-radical formula of necrosis in the lower extremity plus diabetes calls for midthigh amputation.

Today, through better appreciation of the underlying pathological process, the pendulum stands at a happier medium and until new pathological factors are uncovered, this stand is bound to vary little, if at all. A surgeon confronted with a necrotic lesion in an extremity has two major questions to ask before proceeding to formulate a course of therapy. The general condition of the patient is the surgeon's first concern, and once studied and adequately prescribed for, the surgeon

* From the Department of Surgery of Kings County Hospital, Service of Dr. O. Tenopyr.

can turn to the local lesion for scrutiny and thorough investigation.

The first problem involved in the patient's general condition is that of his metabolic status. Is the patient afflicted or not with the syndrome called diabetes mellitus? A history might reveal symptoms or previous treatment, blood sugar, the extent of the derangement and of infection. A blood carbon dioxide combining power reveals the proximity of the patient to acidosis. A preliminary urine sugar acts as an index to evaluate the efficacy of therapy following its institution. Patients without diabetes may be designated as those without metabolic derangement, whereas diabetic patients are classified into three groups:

1. Untreated patients with fasting blood sugars of not more than 180 mg. or when treated are controlled by not more than fifteen daily units of protamine zinc insulin, are classified as suffering from mild metabolic derangement and are designated as +1 diabetic patients.

2. Patients with fasting blood sugars of not more than 300 mg. or when treated are controlled by not more than thirty-five units of protamine zinc insulin daily, are classified as cases with moderate metabolic derangement and are designated as +2 diabetic patients.

3. Patients with fasting blood sugars of more than 300 mg. or when treated require more than thirty-five daily units of protamine zinc insulin are those with marked metabolic derangement and are designated as +3 diabetic patients.

It must always be remembered that the atheromatous condition of the vessels to which much of the pathological condition in the extremity is due does not limit itself to the vessels of the extremity alone, but is usually present in the entire arterial tree. The vessels of the heart and kidneys are rarely spared. A history, therefore, of limitation of the patient's previous activity, previous heart attacks, or a story of effort syndrome may reveal coronary or myocardial impairment. A tracing might help to indicate how soon the patient can be put in a wheel chair after operation without turning pale or begin to perspire and collapse.

The vascular pathological process must have of necessity affected his kidneys to a greater or lesser extent. A low urine specific gravity and a high blood urea might demonstrate the degree of nephrosclerosis and indicate an adjustment in diet and fluid intake.

Once acquainted with the general condition of the patient and having prescribed for the various findings, the attention of the surgeon may be focused upon the local condition and here the investigation has to be more exhaustive.

The first concern is the status of the circulation of the involved extremity. The nutrition of the limb is investigated thoroughly by studying the two major circulations: (1) primary and (2) collateral.

A history of claudication, easy fatigue, pains upon walking, having to rest after a short stroll, night pains in the calves and legs, tingling, numbness, coldness of the extremity, slow growth of the nails, all this would help to appraise the extent of arterial starvation of the extremity. Inspection of the leg might reveal a near mummified condition with loose, dry skin, atrophy of fat and muscles, absence of hair, striation of nails, pallor of the extremity with or without elevation, and with or without exercise.

It must be remembered, nevertheless, that in the literature undue emphasis is laid upon the question of atrophy of the hair and transverse striation of the nails, for while they often are present in vascular lesions these phenomena are part of the senile changes that these organs undergo in the aged and might be marked, despite excellent arterial pulsations or adequate collateral circulation and are, therefore, not always indicative of vascular insufficiency.

Palpation of each of the dorsalis pedis artery, posterior tibial and femoral will reflect the condition of the primary circulation of the leg. Each of these vessels should

be palpated separately and no one vessel can substitute for the others. An extremity with a hardly palpable femoral artery might have a fair dorsalis pedis and vice versa, for at times the collateral network around an occluded vessel might have developed enough to allow for good pulsations farther down in the extremity. The popliteal is difficult to palpate even in a normal limb and cannot be relied upon. Oscillometric readings of the extremity are taken and recorded on the special graph. Tracings are made of each extremity and are taken with the cuff of the oscillometer applied below the ankle, indicated with (BA), above the ankle (AA), below the knee, (BK) and above the knee, (AK).

Neither arterial palpation nor oscillometric readings can solely be relied upon to ascertain the circulatory status of an extremity, for while they give an idea as to the condition of the circulation in the main arteries of the leg, they do not indicate the extent of development of the collateral network. That the collateral circulation might be adequate despite non-pulsating arteries and oscillometric readings of zero is a fact that has been demonstrated time and again. The histamine flare and saline wheel are a disappointment and very misleading and the sole criterion of the circulation in the collateral tree is the history and inspection of the extremity itself.

William's and O'Kane's idea of classifying leg lesions into vascular, infectious or mixed is a helpful one. Their classifications could be greatly simplified, however, if their plus one, plus two, plus three and plus four impairments were changed into plus one for mild impairment, plus two for moderate impairment, and plus three for marked impairment of the circulation of the extremity. Under plus one vascular lesions are classified all lesions with diminished oscillations, but no history of arterial blood hunger and no evidence of atrophy or pallor. Under plus two are classified cases with nonpalpable dorsalis pedis or posterior tibial arteries, but in which the collateral circulation has developed enough so that there is no history and very mild symptoms of arterial insufficiency, claudication, night pains, etc., and no evidence of atrophic changes in the extremity. Plus three cases are those in which the arterial oscillations are zero from below the knee down and with definite history of arterial starvation and evidence of atrophy in the leg. The following table which is a modification of William's and O'Kane's will help to clarify these points:

Symptoms	Plus One	Plus Two	Plus Three
Claudication	None	Mild—3 to 4 blocks	Marked half block or less
Night pains	None	None	Present
Coldness	None	At times	Common
Numbness	None	None	At times
Tingling	None	None	May be present
Signs			
Hair atrophy	May be present	May be present	Present
Muscle and fat atrophy	Absent	Slight	Marked
Striation of nails	May be present	May be present	Present
Femoral pulsations	Present	Diminished	Diminished or absent
Posterior tibial	Diminished	Absent	Absent
Dorsalis pedis	Faint	Absent	Absent
Oscillometric Readings			
Above knee(AK)	3 to 4	2 to 3	0 to 1
Below knee (BK)	2 to 3	1 to 2	0
Above ankle (AA)	1 to 2	0 to 1	0
Below ankle (BA)	0 to 1	0	0

Once the surgeon is satisfied with his evaluation of the circulatory status of the extremity, the virulence and extent of infection should be ascertained. The toxic condition of the patient, the febrile reaction, sweats and positive blood cultures aid in revealing the extent and severity of infection in addition to local edema, redness and tenderness. The amount of discharge plus a smear with *x*-rays for bony involvement complete the appraisal of existing infection.

It is helpful to classify infection under the same three headings used for vascular impairment: Under the plus one group would be classified mild infection, plus two moderate infections and plus three severe infections. The following table elucidates

the points upon which the classification is based:

Symptoms	Plus One	Plus Two	Plus Three
Pain	Absent or mild	Present	Marked
Throbbing	Mild	Moderate or marked	Marked
Signs			
Redness	Slight	Marked	Bronzing
Swelling	Slight	Moderate	Marked
Local heat	Slight	Moderate	Marked
Discharge	None	Slight	Moderate or copious
Temperature	Normal	Up to 100.5	Over 100.5
Inguinal glands	None or slight	Present	Present
Blood culture	Negative	Negative	Negative or Positive
Smear and local culture	Staphylococci	Staphylococci Streptococci Bacillus coli	Streptococci Bacillus coli Bacillus welchii

The classification of infection is not as important as that of the vascular status inasmuch as the degree of infection may vary from day to day whereas vascular impairment hardly changes from one month to the other.

Once the patient's lesion is diagnosed and classified as vascular plus one, infectious plus three, diabetic plus two, (V+ I+++ D++), the surgeon is ready to chart his course of local therapy.

Purely vascular lesions, (plus two) and small (plus three) lesions are watched while treated conservatively. The following is the routine we have found most helpful: (1) Elevation of the head of the bed with one-foot blocks; (2) wrap the affected limb in cotton wool from groin to toe; (3) allow bathroom privileges; walking to bathroom will give patient all the advantages of Buerger's exercises; (4) intravenous salt solution in patients with blood pressure of not more than 185 systolic. Three hundred cc. of 5 per cent sodium chloride are given two to three times weekly. Too much saline is harmful. We have seen inflammation commence or extend rapidly once the extremities became edematous following daily saline infusions. It is a question whether saline helps the lesion proper or not, but the sense of warmth felt in the extremity is greatly appreciated by the patient and pains are greatly diminished following the infusions. (5) Intravenous vitamin B complex seems helpful in certain cases. No other type of medication or injection has been helpful in our hands.

Physiotherapeutic measures have failed us completely. This includes suction pressure, intermittent venous occlusion, oscillating bed, diathermy, dry heat, etc. The successes with these methods reported in the literature may be due to the rest and better nutrition entailed in a hospital stay for the average charity case without these advantages at home. We have not been able to duplicate the reported results in well-to-do patients.

We have had no experience with posterior root or periarterial sympathectomies, but from cases done in other hospitals that occasionally come to amputation in our own, the value of these procedures seems questionable.

We have not attempted femoral or popliteal vein ligation recently, notwithstanding the plausibility of the rationale behind venous occlusion intermittent or otherwise. In actual practice it does not work.

Suppurating cavities are packed daily with 1:500 azochloramid in triacetin gauze. Discharging ulcers are treated with wet soaks, granulating ulcers with coagulents such as tannic acid when the area is small, or skin grafting for large defects. We use petrolatum jelly as a dressing for clean postoperative wounds, but we are disappointed in its use in ointment form whatever the combination. Repeatedly, we have seen freshly healed ulcers with delicate scars break down completely when ointments are applied over a small residual patch of ulceration.

Extensive vascular one or two with infectious plus two or plus three may occasionally be treated by a midcalf amputation. There is no place for a Syms or a Gritti-Stokes or even flap amputation through the lower third of the thigh.

Pure, or mixed vascular plus three lesions and extensive mixed vascular plus

two lesions are treated by amputation through the lower third of the thigh.

OPERATIVE TECHNIC

The technic employed is the following: With 60 mg. of procaine in 1.5 to 2 cc. of cerebrospinal fluid introduced in the third or fourth lumbar interspace, the leg is anesthetized. Formerly, we insisted upon a forty-eight-hour preparation, but the fallacy of this prolonged procedure soon became evident and it has since been reduced from forty-eight hours to ten minutes. Once anesthetized, for ten minutes the leg is first scrubbed from below the knee down to the inguinal and gluteal folds with benzine, then dried with a sterile towel. The leg is then scrubbed with green soap and water, dried and painted with 1.5 per cent tincture of iodine and washed with alcohol. The area around the thigh is suitably draped; the leg is then wrapped and bandaged neatly from the upper border of the patella down to the toes. The leg is held by an assistant while a towel is wrapped over the upper thigh about four-finger breadths above the bandage. A tourniquet is applied over the towel just as the surgeon is ready for his incision. The tourniquet is applied high on the thigh to avoid inversion of the edge of the stump following section.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Figs. 1 to 4. For legend see opposite page.

A circular incision is made with an amputation knife two-finger breadths above the upper border of the patella through skin and muscle down to bone. The femoral artery and vein are doubly ligated and the tourniquet released. Hemostasis is affected, and with a small knife a circular incision is made into the periosteum. The periosteum is reflected first with an angular periosteal elevator, then with gauze to a

Fig. 5.

Fig. 6.

Fig. 7.

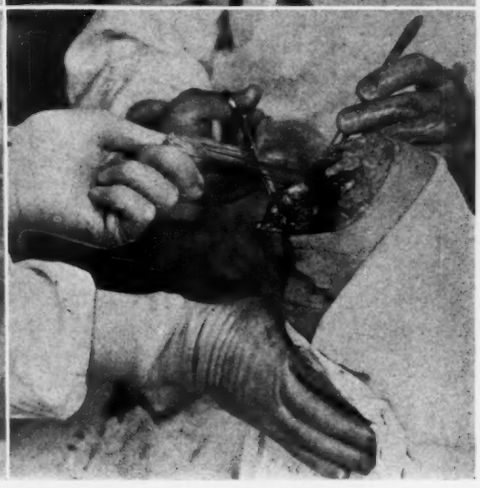


Fig. 8.

Fig. 9.

Fig. 10.

Figs. 1 to 10. Ten steps showing simplified supracondylar thigh amputation.

	No. of Cases	Infected	Clean	Mortality Within Three Days Post-operatively	Total Mortality, Including Deaths in the Hospital Following Discharge from Our Surgical Wards
First period (1916–1939)	49	23 (58.96%)	16 (41.4%)	10 (20.4%)	25 (51.02%)
Second period (1940 and 1941)	24	6 (25%)	18 (75%)	0	9 (37.50%)

distance of four-finger breadths proximal to the initial incision. The stump is protected and the bone is sawed off. Muscles, fascia lata and skin are approximated anteroposteriorly. It is important to suture all opposing muscles together, so that the patient may have proper control of the stump. The principal, "The less exposure of wound, the less chance of infection," is made full use of, hence, the division of the operation into steps and the speed with which each step is executed. (Figs. 1 to 10.)

Unless the sciatic nerve protrudes into the wound, it is left alone, otherwise, it is pulled out and cut short. The suture line in the skin is covered with vaseline and protected with a sheet of cellophane. Vaseline retards adhesion of the edges and promotes oozing; the cellophane permits inspection of the wound without contamination, and a painless change of dressing when the sutures are removed. No posterior splint is used, though at times a soft pillow is placed beneath the stump for comfort.

The above table has been compiled from charts available at the record room, of cases that had had thigh amputations on our service during the past six years. The comparison is made between two periods. The first period is from 1936 to 1939 inclusive, before we had standardized our procedure for handling these cases. The second period includes 1940 and 1941, during which period, the technic described in this paper had been adopted routinely.

The mortality in both groups seems high, but when one considers the type of neglected and often moribund patient, who at last lands in a city hospital after he wastes his money on new salves and gives his last penny to the professor who is going to save his leg, and who even after admission to the hospital continues to refuse operation until the odor has exhausted all the deodorants on the ward and has become unbearable to the patient and his family, one realizes that it is not as bad as it might seem at first glance.

SUMMARY

Six years of experience on the surgical and diabetic wards of the Kings County Hospital have taught us the following:

1. Lesions in the extremities are best classified as vascular, infectious or mixed, with or without metabolic derangement.

2. Diabetes need not be considered when the question of local therapy arises. The choice of conservative or radical therapy depends principally upon the nutrition of the extremity.

3. Physiotherapeutic measures are unreliable and only useful in keeping the patient occupied while the surgeon makes up his mind.

4. Conservative therapy that has been of some help in our hands has been discussed.

5. The technic that in our hands has decreased the mortality and morbidity of amputations has been described.

REFERENCES

Williams, F. W. and O'Kane, T. J. Clinical classification of lesions of the lower extremity associated with diabetes. *Arch. Surg.*, 4: 366–371, 1940.

Tenopyr, O. and Al Akl, F. M. The ideal dressing for clean wounds. *Am. J. Surg.*, 51: 399, 1941.

CEPHALIC BRUIT

A REVIEW OF THE LITERATURE AND A REPORT OF SIX CASES

MAXWELL J. MACKBY, M.D.
BROOKLYN, NEW YORK

NORMAL blood passing through smooth-walled vessels at an average rate of speed and without sudden changes in direction of the current seldom, if ever, produces a murmur detectable by ordinary methods of auscultation. There are, however, a great variety of anatomical anomalies as well as numerous pathological states of the blood vessels (less frequently alteration in the blood itself) that result in a bruit audible over the implicated area and/or transmitted along the vascular current. Abnormal states of the vascular system in the intracranial cavity offer no exception, cephalic bruit occasionally being heard by auscultation of the head. Cushing and Bailey[1] commented "by a strange human frailty, auscultation of the skull seems to be the one thing most likely to be neglected in a routine neurologic examination." If an intracranial murmur is heard, the entire cranium should be auscultated in order to determine the point of greatest intensity of the bruit. In the normal human subject no audible sounds are heard over any part of the head. However partial obstruction to the nasal air passages or labored breathing frequently results in a respiratory murmur transmitted to all parts of the calvarium. These observations have been substantiated by many clinicians, yet this important step in the examination is still frequently omitted.

Various methods of cranial auscultation have been described, each possessing certain advantages. The oldest one is that of placing the ear of the examiner against the ear of the patient. Using a stethoscope with a diaphragm enables one to hear a bruit more often than with the bell-type stethoscope. Still,[2] describes an ingenious device by which two sets of ear-pieces are joined without an intervening chest-piece, with one set being placed in the examiner's ears and the other in the ears of the patient. For routine examination it is advisable to auscultate over five areas of the head: in the middle of the forehead, anterior part of the temporal fossae and just posterior to either mastoid eminence. When auscultating over the lateral occipital region care must be exercised so as to prevent partial occlusion of the greater occipital artery, since a systolic bruit may be inadvertently produced thereby.

In pathological states or where there are anatomical anomalies of the blood vessels of the intracranial cavity, the commonest mechanism for the production of a murmur is the entrance of blood into a zone of greater caliber than that through which it has just passed. For example, an arteriovenous fistula, an aneurysmal varix or a tumor creating wide vascular channels resulting in rapid eddying currents of blood, produce audible cephalic bruit. In the absence of obvious pathological lesions there are certain physical properties contributory in the production of audible bruits. These are: abnormalities in the rate of flow and modifications in the viscosity of the fluid, variations in the distensibility of the channel, and sudden changes in the direction of the current.

Fisher[3] described several cases of cephalic bruit and concluded that the murmur is indicative of organic changes (notably hydrocephalus, meningitis or brain abscess) and is due to pressure of the distended brain on the arteries at the base. However, from a review of the literature it may be said that intracranial bruits in children are often without pathological

significance. To bear out this contention Hamburger[4] cites Osler who "described a case of a healthy 3 year old child with a loud systolic head murmur which was heard by the mother and at times by the child. The murmur could be heard anywhere over the head and ceased on compression of the carotids. The medical attendant had suggested the possibility of aneurysm but Osler, basing his view on the knowledge of the literature at the time gave a favorable prognosis. The mother did not appear satisfied and Dr. Osler heard nothing further of the case for some months when he recognized it 'in the description of a Case of Supposed Gummy Tumor of the Brain in which the murmur was attributed to the possible existence of a syphilitic growth pressing upon the vessels at the base of the brain.' In spite of the two opinions dissenting from Dr. Osler's the child thrived, and when last seen at the age of 7, still had an audible bruit." Still described the case of a healthy boy aged 8, who heard noises in his head and especially in the region of the left ear which were sufficiently distracting to keep him awake at night. A loud systolic murmur was audible by pressing the right ear of the examiner to the left ear of the patient. The presence of a pathological condition to account for this was doubted. Henoch[5] heard cranial bruits in twenty-four out of thirty-three rachitic children, all of whom had open fontanelles. He therefore concluded that rickets is the prime factor in the production of a cephalic murmur. Roger[6] had two patients thirteen and fourteen years of age with marked anemia, both of whom had bruits heard over the frontal and temporal regions. He concluded that in both of his cases and those of Henoch the murmur was due to the anemia accompanying rickets. In support of the idea that anemia can cause cranial bruit a case of Hamburger may be cited. A woman twenty-three years of age with a hemoglobin of 40 per cent and 1,650,000 erythrocytes had a very loud blowing systolic cranial bruit. Still reported a series of 130 infants with closed fontanelles, thirteen of whom had audible cranial bruits, and seventy infants with open fontanelles, of whom seventeen had bruits. Many of these children with murmurs were in apparently perfect health, and the rest were suffering from a wide variety of ailments. Still, Hamburger and others speculate that the frequency of intracranial bruits in children without evidence of organic disease is perhaps due to a "temporary stenosis" of the carotid artery in the carotid canal; i.e. the canal does not enlarge as rapidly as the artery. As an alternative they express the opinion that the carotid artery grows faster than the skull in the early years of life and because of this the artery is apt to become tortuous at the base of the cranium. Later, as the skull enlarges, the artery is enabled to assume a straighter course.

Communications between cephalic arteries and veins, both intra- and extracranial, often give rise to loud murmurs, both subjective and objective. These arteriovenous fistulas are mostly traumatic, but may be congenital or spontaneous. In its commonest form, an anastomosis is created between the internal carotid artery and the cavernous sinus. Pulsating exophthalmos frequently results from this lesion. Hamburger reported a case of this kind, the result of trauma without exophthalmos, in which the murmur, both subjective and objective, persisted nineteen years. Rienhoff[7] also reported a case with a loud cranial bruit which he states was the first intracranial arteriovenous fistula extirpated successfully. Following surgical removal of the fistulous tract the murmur ceased. Pulsating exophthalmos and cranial bruits are infrequently associated with aneurysm of the internal carotid artery, orbital neoplasm and aneurysm of the ophthalmic artery. Bruits are also found in cases of congenital vascular malformations, certain tumors of vascular origin, meningiomas and vascular gliomas. Meyer[8] reported a case in which a glioma overlying the floor of the fourth ventricle was associ-

ated with an audible bruit. It would seem that in most of these cases the murmur is attributable not to the vascularity of the tumor *per se*, but rather to a disturbance of the circulatory dynamics of that region of the brain. A case reported by Hamburger bears out this contention. This patient had a "cerebral glioma with a large cyst in the absence of undue vascularity." Pressure over the right carotid artery caused the murmur to disappear, and pressure over the left carotid diminished the intensity of the bruit. Subtemporal decompressions were performed, the right carotid was ligated, and the bruit ceased for a few days but returned. "The autopsy performed immediately after death and without preliminary fixation of the brain, revealed a very marked displacement downward of the hind brain into the foramen magnum with angulation of the vertebral arteries which had been dragged downward into the vertebral column to a point sufficient to produce angulation of these vessels. This herniation was found to be due to the very high position of the neoplasm, which was located chiefly in the midline. The usual dilatation of the ventricles was present." Beadles[9] has reviewed 555 cases of intracranial aneurysm (not arteriovenous aneurysms) verified as such at autopsy. Murmurs were heard in only two of these. One was an instance of an aneurysm of the vertebral artery, the other an aneurysm of the cavernous portion of the internal carotid. The patient with an aneurysm of the vertebral artery was a male sixty-one years of age with mitral disease. Four days before death, a loud murmur was heard on each side of the cranium between the mastoid process and midline of the neck. At autopsy, an aneurysmal dilatation of the left vertebral artery causing a shallow depression on the anterior surface of the medulla was discovered. However, two other cases of larger aneurysms of the vertebral artery were found in which no cranial bruit was audible. Hutchinson[10] reported a case in which the symptoms were headaches (of ten years' duration), throbbing of the temples, beating in the ears and blurring of vision. The objective signs were paralysis of the structures supplied by the left III and VI cranial nerves. There was a loud bruit audible over both ears. At autopsy, a dilatation of the cavernous portion of the internal carotid artery overlying the gasserian ganglion was discovered. Hamburger cited a case in which there was an aneurysm of the anterior cerebral artery, which pursued an abnormal tortuous course.

Cranial bruits occur most frequently in children between the ages of two months and six years, with the greatest incidence during the second year of life.[2] They have been occasionally reported in adults, remaining for a period of months or years, and then disappearing as mysteriously as they arose. A certain number of these are probably due to arteriovenous fistulas being created between the cavernous sinus and the internal cartoid artery, sometimes indicated by the presence of pulsating exophthalmos,[11] with subsequent spontaneous healing.

REPORT OF CASES

During my internship at The Brooklyn Hospital, it was my privilege to observe six patients with cephalic bruit on the service of Dr. E. Jefferson Browder of the Neurological Unit. Five were adolescents and one was an adult. The following are the case reports:

Case 1. D. S., an eight year old boy was admitted July 13, 1938. The past history revealed that the boy had been in good health until ten months previous to admission when he started to have occasional attacks of vomiting. An exploratory laparotomy was performed at another hospital but did not reveal the causative factor. The child then developed increased irritability, violent headaches, inability to see objects to his right, drowsiness, emotional instability, enuresis and a tendency to fall to the right. On admission at this hospital, physical examination revealed an ataxic gait, the patient falling most often to the right. Over the left parieto-occipital region there was an

audible high-pitched, distant puff-like, resounding bruit, synchronous with the pulse and audible only with the diaphragm and not with the bell type of stethoscope. There were marked bilateral choked disks but the visual fields were grossly normal. There was moderate adiadochokinesis, ataxia of both lower extremities, inconsistent past pointing and marked loss of muscle check movements. The right superficial abdominal reflexes were absent. A ventriculogram showed marked internal hydrocephalus with great dilatation of the lateral, third and part of the fourth ventricles. A cerebellar decompression was performed. The vermis was split in the midline. A steel gray vascular tumor the size of a lemon was exposed extending out of sight along the floor of the fourth ventricle cephalad. Most of the tumor was removed except that directly approximated to the medulla. Microscopic studies of sections of the tumor confirmed the clinical diagnosis of medulloblastoma. Following operation the bruit disappeared, and after a course of roentgen ray therapy the patient improved and was considered to be in fair physical condition, without return of the murmur.

Case II. G. W., a twelve and one-half year old white schoolboy, was admitted on October 14, 1930, with a three year history of intermittent headaches, lasting several hours, and as the boy had a chronic post-nasal drip, they were attributed to sinus trouble. Four months prior to admission the headaches, which were confined to the left side of the head, became much more severe and were accompanied by easy fatiguability and projectile vomiting without nausea. He then developed transient diplopia, the right eye turned in, his gait became unsteady, and there was paresis of the right arm. Physical examination on admission showed a prominence of the right frontal region. A bruit was heard over the occipital region bilaterally. This bruit ceased on compression of the left carotid artery but its intensity was not influenced by compression of the right carotid. The child showed a dull mentality (but had reputedly been very alert and in fact precocious prior to the present illness). There was a right homonymous hemianopsia, and inability to recognize test odors. There was a right facial paresis of the supranuclear type. There were occasional jerky movements of the head and all four extremities, and impairment of coordination of movements of the right upper and lower extremities. The deep reflexes were depressed on the right and exaggerated on the left. Roentgen-ray studies of the skull showed halisteresis and a large calcific deposit lying above the sella turcica with erosion of the sella. On October 16, 1939, a right frontal craniotomy was performed, and on retraction of the right frontal lobe a reddish-grey tumor about 3 cm. in diameter was found between the optic nerves anterior to the chiasm and occupying the space of the eroded sella. The anterior horn of the right lateral ventricle was opened and the third ventricle entered by enlarging the foramen of Monro. A tumor mass was disclosed which filled the inferior portion of the third ventricle, and was taken to be a craniopharyngioma, portions of which were removed for histologic study. The postoperative course was very stormy, with an episode of respiratory failure three days postoperatively. Seven days after the operation the patient developed a massive atelectasis and expired. Autopsy was not obtained.

Case III. L. D., a six year old white female, was admitted on August 5, 1939. Two weeks prior to admission the child had a severe frontal headache which lasted three days and then disappeared completely. During that time, and for the remainder of the week she vomited several times daily. For one week prior to admission she complained of diplopia and the left eye was turned in. On physical examination at the time of admission a bruit of moderate intensity was heard over both temporal areas and over the occiput in the superior nuchal line. Pressure on the right carotid produced little change. There was a left internal strabismus and a left inferior homonymous quadrantal defect. The fundi showed marked bilateral papilledema with engorged veins. A ventriculogram performed on August 7, 1939, disclosed a soft tissue mass in the midline occupying the posterior three-quarters of the third ventricle. On the same day a right frontal craniotomy was done. An area of frontal cortex was excised and the frontal horn of the right ventricle was entered. The third ventricle was exposed through the foramen of Monro, and a tough, yellow, gelatinous tumor mass about 2.5 cm. in diameter arising from the floor and left anterior walls of the ventricle was excised. On histologic study the tumor was diagnosed to be a fibrillary astrocytoma. The patient made a fairly uneventful recovery, but was left with considerable intellectual impairment and a minimal left

hemiparesis. She has been followed in the outpatient department and when last seen on June 20, 1940, no bruit was audible.

Case IV. M. H., an eight year old white schoolgirl, was admitted on March 23, 1939, with a two months' history of suboccipital pain, dull and nonradiating in character. Two weeks after the onset of the pain the patient began to have frequent episodes of nonprojectile vomiting, accompanied and preceded by a short period of nausea. For one week prior to admission the patient had some unsteadiness of gait resulting in several bad falls. On physical examination at the time of admission the child was found to have an inconstant rough bruit distantly heard over the left occipital region. There was a 4 plus papilledema bilaterally, and a coarse nystagmus in all directions. A mild ataxia and apraxia were noted, as well as a bilaterally positive Babinski response. After shaving the head a decided bulge was noted over the occiput. On March 27, 1939, an occipital craniotomy was performed, and on retracting the cerebellar lobes, a bluish red, irregularly nodular and somewhat cystic tumor was disclosed in the midline, occupying most of the fourth ventricle. It was attached to the floor of the fourth ventricle over an area about 1 by 1 cm. in diameter, slightly anterior to the lateral recesses, and to the anterior inferior part of the right cerebellar hemisphere. As much as possible of the tumor was removed which on pathologic study proved to be an unclassified type of glioma. The child made an uneventful recovery and except for some mild ataxia and nystagmus was well at the time of the last examination in September, 1941. No cranial bruit was audible.

Case V. F. W., a fourteen months old white male infant, was admitted on October 6, 1939, with a history of having fallen down a flight of stairs and striking his head on a concrete floor three days previously. He began to cry immediately after the accident and then lost consciousness for a few minutes. The night following the injury he began to develop weakness of the left arm and leg which became more pronounced up until the time of admission. At the same time he developed conjugate deviation of the eyes to the right. On admission there was a loud rough bruit audible over the entire head and loudest at the right temple. There were numerous fresh hemorrhages in the right fundus. There was a relative prominence of the right frontal and temporal regions. The scalp was reddened and edematous over the entire left parietal and upper occipital and temporal regions. The anterior fontanelle was tense and bulged up above the level of the surrounding scalp. There was a left facial paralysis and no spontaneous movements of the left arm, hand or leg. The deep reflexes in the left upper extremity were sluggish. A right parietal craniotomy was performed on October 9, 1939, and a subdural layer of thick, tarry old blood was encountered over the parietal, occipital and temporal fossae, which was washed away with saline. The total amount of blood was estimated at 50 cc. The patient made an uneventful recovery, regaining the use of the left arm and leg prior to discharge. No bruit was heard at the time of discharge.

Case VI. F. R., a twenty-three year old white female schoolteacher, was admitted for the first time on September 3, 1936. At that time she gave a history of a fall five years previously, when she struck her head severely, and was momentarily dazed. Four weeks later she suddenly had a generalized convulsion, with loss of consciousness, and from then on experienced two or three such seizures every year. She also suffered almost daily attacks of petit mal during which she would be unable to move or speak for several minutes. The second year of her seizures she began to take phenobarbital, was free of attacks for eighteen months and was able to return to school. Following this period the attacks returned in a much milder form, and at the time of the first admission the only abnormality noted was a slight left facial weakness and a partial right homonymous hemianopsia. An encephalogram demonstrated an asymmetrical cerebral ventricular system, the right anterior and posterior horns being smaller than the left. A right temporal craniotomy on October 14, 1936, disclosed a hemangioblastic malformation in the region of the right Sylvian fissure. Nothing other than visualization of the lesion was attempted at this time. On November 3, 1938, the patient tripped and fell down a flight of stairs, striking her right hand which she had raised to protect her head, and sustaining a Colles' fracture of the right wrist. In December of that year she began to have recurrences of convulsions and her students noticed that she dropped things out of her hands with abnormal frequency. In July, 1939, as a preliminary step for ligation

of the right internal carotid artery, she was instructed to carry out intermittent compression of the common carotid on this side. She was readmitted on September 19, 1939, and at this time it was noted that at a point 4 cm. anterosuperior to the upper edge of the right ear, a soft bruit was heard, synchronous with the carotid pulsations in the neck. Moderate pressure on the right common carotid artery modified the quality of the bruit to a whirring noise. The patient seemed immature mentally, talkative, and at times silly. There was a slight left facial weakness. The Romberg test was positive. On September 20, 1939, the right internal carotid artery was ligated under local anesthesia without producing any untoward symptoms. The patient was discharged on Oct. 2, 1939, without having had any further convulsive seizures. However, the bruit was still audible.

In reviewing the literature on the subject of head murmurs, no definite conclusion could be drawn as to the incidence of bruit in the population at large as compared with its occurrence in the patient suffering from an intracranial lesion. Accordingly, it was suggested that auscultation of a large enough series of individuals would furnish some information on this point. The group so examined were:

100 ambulatory patients from The Brooklyn Hospital Cardiac Clinic, suffering from all the common varieties of heart disease

75 patients from the Medical and Surgical wards of The Brooklyn Hospital

75 apparently healthy persons from the personnel and professional staffs of the hospital.

The technic of examination consisted of auscultation over the frontal, temporal and parietal regions, with the patient in the prone and sitting positions, and in the erect position after one minute of running in place.

Of the seventy-five healthy persons examined, not one had an audible cephalic bruit. Of the seventy-five hospital patients examined, one boy eleven years old with the very loud presystolic murmur of advanced mitral stenosis, had a very faint high-pitched bruit over the right temporal region only while lying in the left lateral position. The bruit was synchronous with the heart murmur. Of the one hundred patients examined in the Cardiac Clinic, two patients with cephalic murmurs were encountered, one in a patient with advanced mitral stenosis and aortic insufficiency (a female twenty-six years of age). When examined in the sitting position, a faint, high pitched bruit was audible over the right temporal region, synchronous with the presystolic heart murmur. The other was in a man of sixty-three who had advanced hypertensive and arteriosclerotic cardiovascular disease with a blood pressure of 240/180. There was a rather rough, faint, low-pitched murmur heard over the left parietal region in this case. None of these three patients had any neurological complaints, except the last who had occasional tinnitus and vertigo, with severe frontal headache. Examination in all three patients revealed no abnormal neurological findings.

SUMMARY AND CONCLUSIONS

It appears that cranial auscultation is a "near forgotten art." This method of examination is seldom employed by the average practitioner although simple of execution, and from such an examination one may derive valuable information. The pertinent features of the subject as recorded in the literature have been reviewed. Six examples of intracranial bruit occurring in patients harboring intracranial lesions have been reported in order to illustrate some of the pathologic states that may result in a bruit. In an endeavor to estimate the frequency of occurrence of this abnormal physical finding in persons not exhibiting signs of intracranial disturbances, the heads of 250 persons were auscultated. Cephalic bruit was demonstrated in only three instances (0.012 per cent) and in two of these cases there was a murmur audible over the heart, the great vessels of the neck and the head. From the

evidence at hand, it seems logical to conclude that a cephalic bruit in any individual merits careful consideration and further investigation of the possible presence of an organic intracranial lesion.

REFERENCES

1. CUSHING, H. and BAILEY, P. Tumors arising from the blood vessels on the brain. P. 71, 1928.
2. STILL, G. F. *Brit. J. Child. Dis.*, 18: 173, 1921.
3. FISHER, J. D. *Am. J. M. Sc.*, 44: 24, 1938.
4. HAMBURGER, L. P. *Am. J. M. Sc.*, 181: 756, 1931.
5. HENOCH. *Beitr. z. Kinderb.*, 1861, 170.
6. ROGER. *Recherches Clin. sur les maladies de l'enfance*, 103: 29, 1883.
7. RIENHOFF, W. F., JR. *Bull. Johns Hopkins Hosp.*, 35: 271, 1924.
8. MEYER, A. *Arch. Neurol. & Psychiat.*, 4: 387, 1920.
9. BEADLES, C. F. *Brain*, 30: 285, 1907.
10. HUTCHINSON. Cited by OLIVER, C. A. *New York State J. Med.*, 79: 691, 1904.
11. DESCHWEINITZ and HOLLOWAY. Pulsating Exophthalmos. Pp. 38 and 71, 1908.

Chronic osteomyelitis is always a slow process. Complete healing never occurs until all sequestra have been removed, or sloughed out, and subsequent recurrence of the condition by lighting up of latent infection is common. This may happen many years after the original infection has healed.

From—"A Manual of the Treatment of Fractures"—by John A. Caldwell (Charles C. Thomas).

PROLONGED STUPOR PRODUCED BY SUBDURAL HYGROMA*

RELIEF BY TREPHINE AND DRAINAGE

MICHAEL SCOTT, M.D.
Assistant Professor of Neurosurgery, Temple University Hospital and Medical School
PHILADELPHIA, PENNSYLVANIA

THE subdural space which lies between the arachnoid and dura mater normally contains a thin layer of fluid called subdural fluid (Weed, Penfield).[1]

Although the mechanism of production and accumulation of this subdural fluid is not known, it is definite that following a head injury there may be an accumulation of fluid in the subdural space which takes up volume and exerts pressure against the brain in a manner similar to subdural hematoma or clot.

The term chronic subdural hydroma or hygroma, meaning an excessive amount of clear fluid in the subdural space following a head injury, was first introduced by Dandy.[2] Since then this condition has been described by Naffziger, Fay, Cohen, Walsh and Sheldon, Love and others.[3,4,5,6]

It is the purpose of this paper to present three cases of head injury showing prolonged stupor produced by subdural hydromas and relieved by simple trephine and drainage of the subdural space.

CASE REPORTS

CASE 1. A child, aged two, was admitted on June 5, 1935, with a history of inability to talk, weakness and fine purposeless movements of his right hand and arm. On May 10, 1935, he had been struck by an auto and on the second day after the accident the child had a right-sided convulsion. He was then unconscious for five days. An *x*-ray of the skull showed a linear fracture of the left frontal bone and the left femur. The sixth day after the accident the child appeared to regain consciousness and spinal puncture revealed slightly blood-tinged fluid. Eight days after the accident it was noticed that the left pupil was dilated and was fixed to light. Another spinal puncture done at this time yielded 18 cc. of moderately bloody spinal fluid. The patient began to improve gradually but because of the aphasia, weakness of the right arm and choreaform movements of the right upper extremity, he was hospitalized about twenty-five days after the accident.

Examination. The child appeared to understand simple commands but could not talk. He would extend his tongue when requested to do so. There was dullness to percussion, bilaterally, over both frontal regions. The pupils were both dilated but reacted well to light. There was no co-operation to accommodation. The discs showed no choking and the ocular movements appeared normal. There seemed to be relaxation of the left lower one-third of the face. The deep tendon reflexes were bilaterally hyperactive. Hoffman and Babinski signs were not present. Forced grasping with cog-wheel rigidity was present in the right upper extremity. Muscle power was decreased in this extremity and choreaform, purposeless movements were present. *X*-ray showed a linear fracture of the left frontal bone.

An exploratory trephine was done in the left temporoparietal area by Dr. Fay one month after the accident and four ounces of clear subdural fluid was evacuated from the subdural space. There was no evidence of any subdural bleeding or clot.

On the fourth postoperative night the child called "Mama." On the tenth day after the operation the child could speak small sentences and two syllable words. The patient was discharged on the eighteenth day sitting up and talking. There was still some ataxia in the right upper extremity.

* From the Department of Neurology and Neurosurgery, headed by Dr. Temple Fay, Temple University Hospital and Temple University School of Medicine. Presented before the Philadelphia Neurological Society, December, 1939.

When seen again three months later, he was running about, alert, and could recite many small poems.

Case II. J. K., aged nineteen, was admitted on July 11, 1939, because of unconsciousness for a period of twenty-three days. On June 18th the patient fell and struck his head. He was taken to a hospital unconscious, in shock and bleeding from the right nostril. A spinal puncture done at this time showed very bloody fluid. The examination revealed pupils equal in size and there were no recorded signs of any abnormal neurological findings except for the stupor. An *x*-ray of the skull showed a fracture of the right frontal bone extending into the orbit. There was no depression of fragments. Repeated spinal punctures were done. However, his condition did not improve and he was sent to the neurosurgical service of Temple University Hospital twenty-three days after the accident.

Examination. When first seen, the patient was unconscious, tossed about the bed, his mouth was opened and relaxed. Percussion of the head showed dullness in the left parietal region. The pupils were equal, regular and reacted to light. The right side of the face appeared relaxed. On passive elevation the right upper extremity fell more limply than the left suggesting weakness of the right arm. The deep tendon reflexes were slightly increased on the right and a Babinski and Oppenheim sign were present on this side. There was slight eversion of the right lower extremity. The eyegrounds showed no choke.

Temperature was 102°F., pulse 100, respirations 20 and blood pressure 120/80. Spinal puncture yielded only a few cc. and the fluid was clear. The pressure was low. The *x*-ray of the skull showed a fracture of the right orbit and the left frontal bone. The pineal gland could not be visualized.

Operation. A diagnosis of subdural hematoma on the left, possibly bilateral, was made and twenty-six days after the accident a bilateral trephine was done by the writer. An opening was made over the left temporofrontal area. The dura was slightly tense and about 3 mm. in thickness. The cortex appeared pale, the gyri flattened, and the pial capillaries decreased in number but congested. The brain was gently retracted and about three ounces of clear subdural fluid evacuated. A drain was placed in the subdural space and carried out through the incision. A similar trephine opening was made in the posterior parietal region on the right. The dura was only moderately thickened. The cortex again appeared pale. Only one ounce of clear subdural fluid was found on this side.

Clinical Course. Following the operation the patient made a gradual convalescence. On the third day postoperatively the patient said "yes" to his nurse when asked if he wished to see his mother. He was discharged three weeks after the operation markedly improved. He could walk with support, he was alert and interested in his environment but showed a partial aphasia. There was still some retardation and weakness of the right leg present. When seen one year later the patient had made a complete recovery. He was keen mentally and had no complaints except for occasional headache.

Case III. F. C., male, aged sixty-nine, was admitted on September 19, 1939 with a history of stupor following a head injury twenty-eight days prior to admission. The patient was injured in a train wreck and was unconscious for forty-eight hours. He then regained consciousness and talked but gradually failed for the next ten days and he had been unconscious for approximately sixteen days when he was admitted to Temple University Hospital.

Examination. The patient was stuporous on admission. The pupils were miotic (patient had received a sedative for the trip, morphine). There was dullness on percussion of the left side of the head. There appeared to be slight weakness of the right lower face on expressional movement to painful stimuli. All extremities were moved on painful stimuli but the right lower extremity was not moved as well as the left. A bilateral Babinski and Chaddock sign were present. Temperature was 102°F., pulse 90, respirations 16 and blood pressure 120/70.

X-ray revealed a fracture in the left temporal bone but no shift of the pineal gland. A diagnosis of subdural hematoma was made and operation was done by Dr. Temple Fay.

Operation (One month after the injury). A trephine was done over the left midfrontal area. The exposed dura was light green in color. Upon its incision a fine membrane was seen. Upon opening this membrane there was a gush of golden yellow subdural fluid. At least three ounces was aspirated before the cortex could be seen, almost an inch from the dura. This space was drained but the patient did not

improve materially. Five days later a trephine opening was made over the right posterior superior parietal area and a similar cyst was encountered. About four ounces of subdural xanthochromic fluid was removed. The patient then had a stormy convalescence but finally made a complete recovery and walked out of the hospital on October 18, 1939, one month after his admission and two months after his injury.

The bilateral, equal collections of subdural fluid accounted for the lack of shift of the pineal gland. The subdural fluid in this case showed 3000 and 5000 mg. of protein per 100 cc., respectively.

CONCLUSIONS

Three cases of head injury having histories of prolonged periods of unconsciousness are presented. In two cases large collections of clear subdural fluid were found and drained; in one the classical type of zanthochromic subdural cyst was found. In every case the patients returned to consciousness following the drainage.

Since an ounce of clear fluid takes up just as much space as an ounce of blood or clot, it can be seen that these subdural hygromas produced symptoms identical to those of subdural hematoma. This type of lesion should be suspected in every case of head injury which does not show the usual trend to recovery after proper measures for relief of intracranial pressure and edema have been used.

The treatment is similar to that used in liquid subdural hematomas. An exploratory trephine or Hudson burr opening is made usually over the posterior superior part of the parietal bone. The dura is opened, the subdural fluid evacuated, and the subdural space drained for twenty-four to forty-eight hours with a small cigarette drain. If excessive fluid is not found on the suspected side, or relief has not been obtained three to five days after one side has been drained, the opposite side should be inspected.

REFERENCES

1. Penfield, Wilder. *Anat. Rec.*, 28: 173, 1924.
2. Love, J. S. Bilateral chronic subdural hydroma, *J. Nerv. & Ment. Dis.*, 85: 161–166, 1937.
3. Naffziger, H. C. Subdural fluid accumulation following head injury. *J. A. M. A.*, 82: 1751–1752, 1924.
4. Fay, Temple. Personal communication.
5. Cohen, Ira. Chronic subdural accumulation of spinal fluid after cranial trauma. *Arch. Neurol. & Psychiat.*, 18: 709–723, 1927.
6. Walsh, M. N. and Sheldon, C. H. Acute subdural hydroma. *Proc. Staff Meet., Mayo Clin.*, 12: 134–136, 1937.

A METHOD OF SUSPENDING THE UTERUS WITHOUT OPEN ABDOMINAL INCISION*

USE OF THE PERITONEOSCOPE AND A SPECIAL NEEDLE

J. K. DONALDSON, M.D.,
Associate Professor of Surgery, University of Arkansas School of Medicine and Hospital

JOE H. SANDERLIN, M.D. AND WM. B. HARRELL, JR., M.D.
Professor of Gynecology, University of Arkansas School of Medicine and Hospital
Resident in Gynecology and Obstetrics, University Hospital

LITTLE ROCK, ARKANSAS

ONE of us (J. K. D.) while doing closed intrapleural pneumonolysis operations with a thoracoscope in 1938, conceived the possibility of accomplishing the Olshausen suspension of the uterus without abdominal incision; and devised a needle (Fig. 8) whereby this could be done by utilizing the peritoneoscope.

Before attempting the operation upon human beings, we ran a series of experiments with twenty dogs investigating the feasibility of technic and the density and permanence of fixation between the round ligaments and the abdominal wall as achieved with the Olshausen suspension. (Fig. 1.) Experimental investigation as to the density and permanence of fixation was, in one sense, unnecessary since the Olshausen has been accepted as a legitimate method of suspension of the uterus for many years. (The two horns of the uterus of the dog were suspended as a correlation to suspension of the round ligaments in the human.)

It is to be remembered that Graves listed the Olshausen as his suspension of general preference in his textbook of gynecology.[1] And since the end results of the procedure we describe are the same exactly as those of the Olshausen, we feel more secure in presenting this method than if it were a new operation instead of a new technic for doing a procedure which has been accepted for many years.

We do not choose to enter here into the long standing discussion relative to the advantages of different types of suspensions. We are well aware that each gynecologist and surgeon is inclined to be dogmatic regarding his particular preference. Suffice it to say that the two senior authors have preferred the Olshausen and Gilliam, respectively, for many years. And if one should prefer the latter, it, too, as suggested by one of us (J. H. S.) can be done with the peritoneoscope without openly incising into the peritoneal cavity. Furthermore, we believe modifications of the Alexander suspension could likewise be done though we have not experimented in this regard.

ADVANTAGES OF THE OPERATION

Intestinal obstruction is not an especially frequent sequela of abdominal adhesions but it is certainly a serious disorder when it occurs. For this reason if for no other, any surgical procedure which will diminish the extent and incidence of adhesions deserves consideration, everything else being equal. Certainly there is much less raw surface created in this operation than with one in which an incision several inches in length is made into the peritoneal cavity.

After routine diagnostic peritoneoscopy, Ruddock and others permit the patient to become ambulatory immediately. The

* From the Departments of Surgery and Gynecology, University of Arkansas School of Medicine and Hospital, and St. Vincents Infirmary, Little Rock, Arkansas.

question arises as to how soon after this suspension operation the patient may become ambulatory from a standpoint of possible interference with the attachment of the round ligaments. In considering this question we reached a tentative conclusion that the weight of the uterus on the round ligaments and the stitches used for suspending it, would be little if any more with the patient in an upright position than with the patient lying in bed upon her back. Consequently we have permitted our patients to become ambulatory within twenty-four hours after the operation or as soon thereafter as they desired. Some of them who are more sensitive to pain elect to stay in bed four or five days but the majority have elected to become ambulatory on the second to third postoperative day. There is some postoperative soreness in the lower part of the abdominal wall where the stitches have been inserted through the rectus muscles; and when tension is produced upon the recti, it will cause some discomfort for ten to eighteen postoperative days. But this discomfort is not marked as a rule, not at all comparable to the pain and soreness which follows open incisions.

Fig. 1. Shows an actual experimental specimen in which the Olshausen procedure was done in a dog. The specimen is part of the abdominal wall which has been cut away and shows the cornu of the uterus (used as correlation to the round ligament) six weeks postoperatively after it was attached by the Olshausen stitch. It exemplifies the strong fibrous tissue sealing of structures which occurs throughout the area encircled by the stitch.

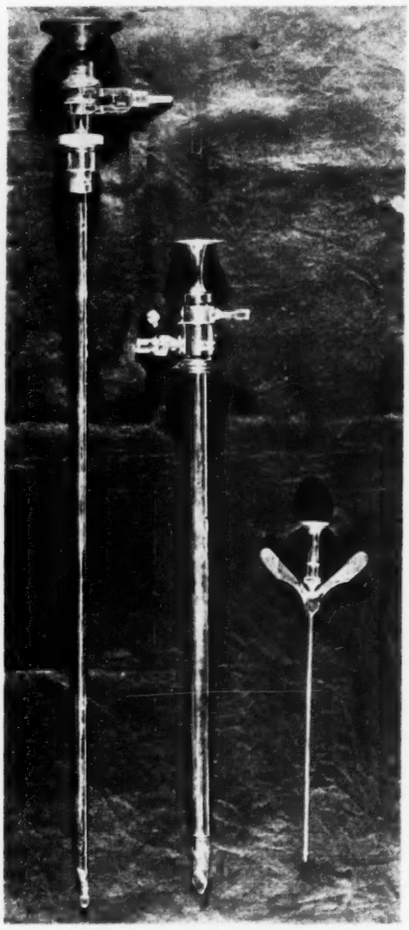


Fig. 2. The long shafted instrument on the left is the lens instrument of the Ruddock peritoneoscope. The small needle on the right is first introduced into the peritoneal cavity and a rubber bulb inflator used to distend the peritoneal cavity with air in order that the trochar shown in the center may be safely passed into the cavity without injuring the gut. After the trochar is introduced, the lens instrument is inserted and visualization of the pelvic organs effected.

There is no shock to the procedure we describe and no reason for keeping the patient in the hospital more than twenty-four to forty-eight hours. The latter, of course, effects an appreciable economic saving.

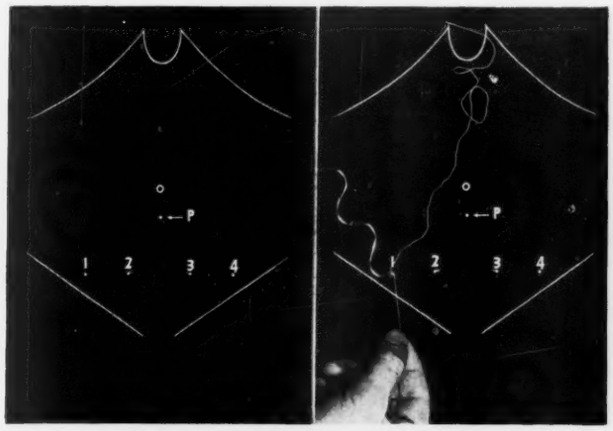


Fig. 3.

Fig. 4.

Fig. 3. o represents the umbilicus; and points 1, 2, 3 and 4, indicate on each side the sites of entrance and exit from the abdominal wall of the needle point. By proper manipulation, it is possible to have the sites of entrance and exit of the needle upon the inner aspect of the abdominal wall about one-half inch apart. This photograph is incorrect in our revised technic in that P is no longer used as the site of introduction for the peritoneoscope. Since the peritoneoscope is rather long, we now elect to introduce it about one inch above the level of the umbilicus through the middle of the left rectus. If one introduces it at the point P, the lens of the instrument will frequently impinge upon the structures of the pelvis and interfere with vision.

Fig. 4. The knife-edged point of the needle is illustrated as puncturing the skin at point 1. The point will be carried directly through the abdominal wall and passed around the round ligament under peritoneoscopic vision. The needle point will then be directed out at site 2.

There is less likelihood of contaminating the abdominal wall structures and peritoneum than in an open operation, and obviously there should be a decreased incidence of postoperative hernia and postoperative laxity of the abdominal wall of which some women complain after open incision. Of course we appreciate that these latter arguments are minor.

INDICATIONS FOR OPERATION

We do not claim that this procedure has a tremendously wide applicability. We know that a certain percentage of retroverted uteri do not give symptoms and do not create additional pelvic pathological conditions. However, most physicians and surgeons agree that the majority of marked retroversions of the uterus do cause low backache, predispose to general irritability of the nervous system, as well as to cystic degeneration of the ovaries. It would be academic to enter further into a discussion of signs, symptoms and pathologic physiology of a subject which has been as thoroughly discussed as retroversion of the uterus.

In short it may be said that consideration of this operation is indicated in any case in which surgery would be advised for retroversion alone. We will venture to say that we would recommend this procedure a little more quickly than we would open abdominal incision operations since the advantages, as outlined above, make it a less annoying procedure to the patient as well as a less dangerous one. In this sense we believe that possibly the operation could

widen the indications for suspensions to some extent.

Certainly if perineorrhaphy is indicated, as it usually is, it obviously should be done. If one accepts the dictum that perineorrhaphy alone will keep a patient in bed for two weeks, some of the value of the suspension by peritoneoscopic method will have been lost. We cannot but present the method, however, with reserved enthusiasm and definitely believe that if those operators experienced in peritoneoscopic and gynecologic surgery will familiarize themselves with it, they will grant it a limited but definite place in the surgical armamentarium.

As indicated by the few cases which we report at present, we have selected carefully the patients upon whom we have done this procedure. Out of a rather active clinical and hospital service we have elected to do this operation only twelve times in the past six months. In each case there was a third degree retroversion of the uterus giving signs and symptoms warranting open abdominal incision; and in each patient there was no other intra-abdominal pathological condition which indicated operation. The operation has been successfully executed in every case, and the uterus has remained firmly suspended to date in its new position despite the fact that we have permitted the patient to become ambulatory within the time limits mentioned above.

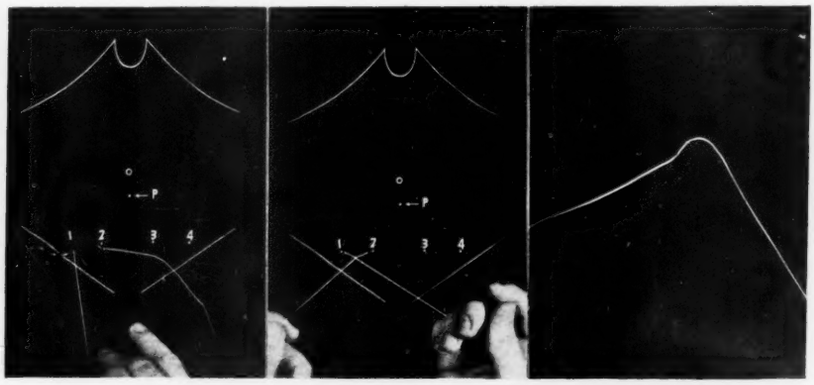


FIG. 5. FIG. 6. FIG. 7.

FIG. 5. Shows the tip of the needle at its point of exit through the skin of the abdominal wall, the suture extending from point 2 being shown as having been pulled from the point of the needle through the abdominal cavity from its companion end of the suture which is shown as held in the fingers of the operator.

FIG. 6. This photograph illustrates the tying of the suture. The suture is *not* tied over the skin, however, as one might conceive from the illustration. Mosquito or small straight hemostat jaws are tunnelled through beneath the skin next to the anterior rectus sheath, from point 1 to point 2 for example. The suture is grasped as it emerges from point 2 and brought through the tunnel. The suture knot is tied firmly through point 1 down on the fascia, it rarely being necessary to enlarge the nick in the skin at point 1 for this purpose. This suture when tied quite firmly gives exactly the same end result as the Olshausen procedure with the suture buried completely, except that we elect to tie our sutures transversely to the rectus fibers whereas in the Olshausen procedure as described by Graves, they are tied parallel to the rectus fibers.

FIG. 7. This photograph illustrates the suture after it has been passed about the round ligament and tied. The tissues wrinkle and fold together in tight proximity, becoming sealed by fibrous union as illustrated in the experimental specimen, Figure 1.

TECHNIC

Those not familiar with the use of the peritoneoscope can scarcely appreciate the ease with which this operative procedure can be accomplished by one experienced in peritoneoscopy. Space will not permit us to

discuss the technic of the latter in detail in this publication, but any experienced surgeon should have very little difficulty in mastering it. In fact we consider examination of the pelvic organs of the female by this method as being less difficult than an ordinary cystoscopic examination.

We use a general or spinal anesthetic usually. The operation can be done under local anesthesia if heavy doses of preliminary medication are given, but it is difficult to avoid some pain as manipulation is carried out under local.

After the peritoneal cavity is inflated, the peritoneoscope is introduced essentially by the technic previously described by Ruddock[2] except that we introduce it through the middle of the rectus muscle (usually the left) about one inch above the level of the umbilicus. (Fig. 9.) We do this because of the length of the peritoneoscope. Otherwise the lens of the instrument may extend too far into the pelvis and interfere with proper visualization.

If visualization of the pelvic structures indicates a continuation of the operation, a match-head sized nick is made in the skin at a point approximately 1 to 1½ cm. above the superior border of the symphysis (unless there is marked uterine prolapse indicating a higher suspension) and about 3 to 3½ cm. lateral to the midline in the left or right hypogastric region depending upon which round ligament is to be suspended first. Then the knife-edged point of the specially designed round ligament needle (Fig. 4) threaded with a long strong silk suture is passed directly through the nick in the skin and through the abdominal wall structures. The tip of the needle is easily seen through the peritoneoscope as it passes through the peritoneum and should be watched as it enters the peritoneal cavity. It is perhaps best to keep the needle point in the visual field from then on until it is withdrawn and the point is, of course, kept well away from bladder and bowel. We have experienced no difficulty in our cases in feeling perfect security in the handling of the needle.

The needle is worked downward on its curves to the point necessary, depending upon the thickness of the abdominal wall,

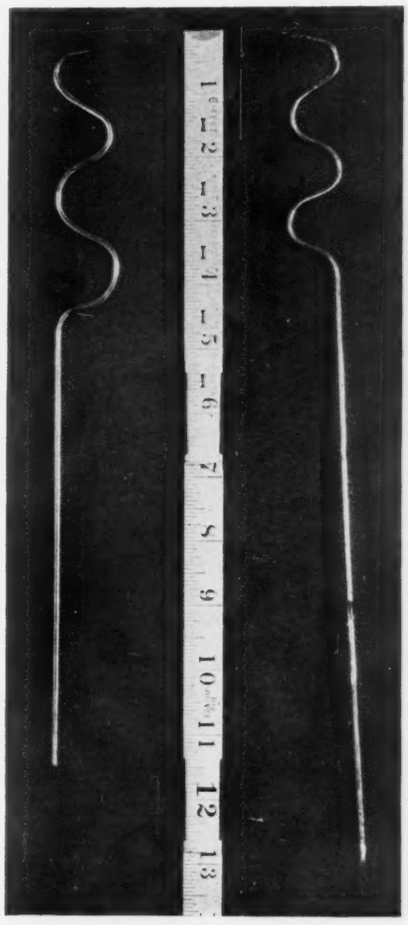


Fig. 8. Shows the different sizes of the round ligament suspension needle. The needle is made of spring steel. It has an eye in the knife-edge at the tip. As described under *Technic*, the curves are in the needle to facilitate intra-abdominal manipulation of the needle tip, with a minimum of trauma to the abdominal wall, the latter falling into the curves in any position in which the needle is manipulated. In subsequent models of the needle, we have adopted a handle which is flat and wide at the end with a marker to designate the side of the handle which faces in the same direction as the tip of the needle. The smaller size needle is sufficiently large for all except the thickest abdominal walls.

and passed just under the round ligament at the point selected. The curved shaft of the needle is then worked back through the

abdominal wall with the round ligament resting in the apex of the first (needle point) curve. At the point where the proximal

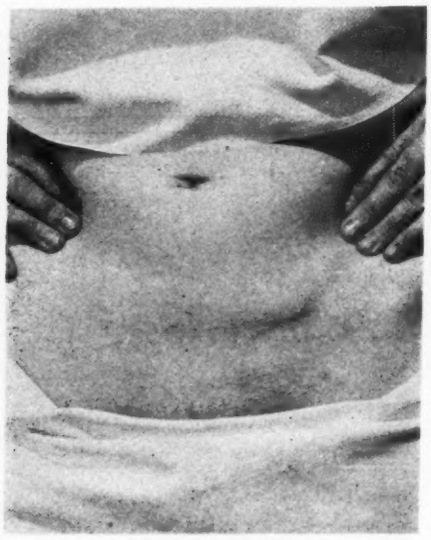


Fig. 9. This photograph was selected as showing the rather typical appearance of the abdomen seven days postoperatively. In this patient the nick in the skin at point 4 was enlarged slightly to facilitate tying the suture securely down on the anterior rectus sheath. It was not necessary to take a stitch in the skin at this point, however, and it is rarely necessary to enlarge the original nick at all. In this patient the round ligaments were suspended somewhat higher on the abdominal wall than usual since considerable prolapse of the uterus was present.

part of the distal or "first" curve in which the ligament is resting reaches the abdominal wall, the shaft of the needle is depressed and the point of the needle directed out through the abdominal wall structures, namely, peritoneum, muscles and fascia, to the skin. As the skin bulges to the point of the needle, a small nick is made in the skin with a scalpel at this site. One strand of the suture which is then presenting itself through the needle eye is grasped with a small hemostat and its free end drawn out through the puncture wound through which the point of the needle has emerged from the peritoneal cavity. The assistant has retained the other end of the suture at the site through which the needle point was introduced into the cavity. (Fig. 5.) The needle tip is then withdrawn through the site where it was originally introduced and freed from the suture which is now resting

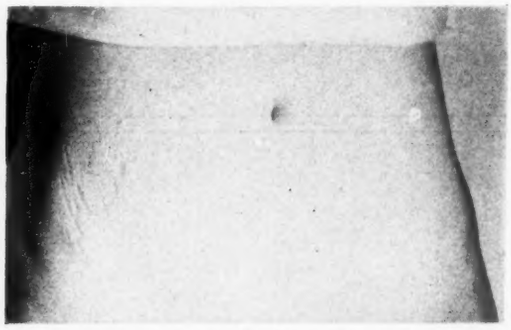


Fig. 10. This photograph shows the typical essential absence of scars three months postoperatively.

beneath the round ligament through the rectus and its fascia just as in the Olshausen procedure. The tip of a mosquito hemostat is now introduced through the original nick in the skin, tunnelled next to the anterior sheath of the rectus until the tip of the hemostat emerges from the second puncture opening in the skin. The strand of the suture emerging from the latter opening is then pulled back through the original puncture wound in the skin by the small hemostat. The suture is then tied with tension over the fascia as in the original Olshausen procedure. (Fig. 6.) While the operator is placing these ties in position, the assistant should observe through the peritoneoscope to insure that a snug approximation is procured. (Fig. 7.) *It is essential that the stitch be tied tightly* with the ligament in very close approximation with the abdominal wall structures. The stitch must cause a necrosis of all the tissues within it because thereby, as described by Graves and Olshausen, a firm fibrous band seals together all the structures enclosed in the stitch. (Fig. 1.)

The curves in the needle facilitate intra-abdominal manipulation of it. (Fig. 8.) By resting the abdominal wall tissues in the proper curve, one may manipulate the needle into any desired intra-abdominal position without undue trauma to the abdominal wall. A straight needle shaft would not permit such atraumatic manipu-

lation in the majority of instances since the abdominal wall tissues would be distorted and traumatized instead of "sliding" into the curve in which they rest with the needle described as intra-abdominal manipulation is carried out.

The first part of the procedure being completed, the same routine is carried out on the other side of the abdomen and the opposite round ligament secured in the same manner as the first. After final peritoneoscopic inspection, the air is permitted to escape from the abdominal cavity and the peritoneoscopic apparatus removed.

We place one stitch or skin clip in the skin at the puncture site through which the peritoneoscope was passed. One does not place stitches in the nicked areas in the hypogastric regions.

The entire operative procedure can be carried out easily by an experienced operator in fifteen minutes in properly selected cases.*

SUMMARY

We present a new technic for carrying out the Olshausen type of suspension of the uterus, by use of the peritoneoscope and a special needle.

Since the technic does not require open abdominal incision, we permit the patients to become ambulatory on the second or third postoperative day if they choose when perineorrhaphy has not been done.

Since there is no necessity for more than twenty-four to forty-eight hours hospitalization, an appreciable economic saving is offered the patient.

The operation has been done only in those instances in which no intra-abdominal work other than suspension of the uterus was needed.

REFERENCES

1. Graves, William P. Gynecology. Philadelphia, 1924. W. B. Saunders Company.
2. Ruddock, John C. Peritoneoscopy. *Surg., Gynec. & Obst.*, 65: 623, 1937.

* We have performed this operation upon five additional patients since submitting the above paper for publication. These few cases, however, are not exactly indicative of the frequency with which the operation properly can be performed on an active service, since other investigative procedures and heavy operating schedules have interfered with our collection of suitable clinical material.

We have been able to follow about one-half of our patients postoperatively. In no instance has there been a recurrence of the retroversion over the period of time extending back through 1939, this being the year we first performed the procedure upon humans.

THE DIAGNOSIS OF UTERINE RUPTURE*

A. SADOWSKY, M.D.
JERUSALEM, PALESTINE

MANY authors consider uterine rupture during pregnancy or labor to be the most serious complication in obstetrics. Although great attention has been paid to this problem, and although all symptoms of threatened and actual rupture are given in textbooks, there are many cases in which the diagnosis of uterine rupture meets with difficulties.

Reviewing the material of the Department of Obstetrics of the Hadassah University Hospital for ten years (1929 to 1938) it will be seen that the determination of the moment of rupture is of great importance for the selection of the best method of intervention. The prognosis for the mother is less favorable when a uterine rupture is diagnosed long after it has occurred or when the rupture is diagnosed after delivery of the child. The results for the mother are much better when the child is delivered through the abdominal incision made for a subsequent *extirpatio uteri*, than when the uterus is removed only after the child has been delivered per vagina.

In our Department of Obstetrics we had during a period of ten years (1929 to 1938) thirteen cases of uterine rupture among a total of 9,079 deliveries, i.e., an incidence of 1:698 or 0.14 per cent. In the statistics reported in the literature we find great differences regarding the frequency of uterine rupture. Stoeckel[1] gives a rate of from 1:235 to 1:6100. Kupferberg[2] reviewing a period of twenty years, reports twenty-four cases or 0.1 per cent. Wlassow[3] reports eight cases among 34,650 deliveries, i.e., an incidence of 1:4331, or 0.023 per cent. Sheldon[4] reports twenty-six cases among 47,554 deliveries or 0.05 per cent (1:1839).

The widespread performance of cesarean section and the indiscriminate use of pituitary extracts during labor are responsible for a great number of cases of *ruptura uteri* (DeLee[5]). This was confirmed by Kupferberg[2] who, reviewing the cases of uterine rupture during a period of twenty years, found a rate of 0.3 per cent in the first twelve years, while during the last eight years this rate rose to 3 per cent. We are unable to confirm this fact from our material. During the first five years (1929 to 1933) we had seven cases and during the last five years (1934 to 1938) six cases, while the number of deliveries during the second half was almost twice that of the first (1929 to 1933, 3,446 deliveries; 1934 to 1938, 5,633).

Uterine rupture occurs more frequently in multiparae and the danger of rupture increases with the number of deliveries. DeLee[5] thinks that the rate is eight times higher in multiparae than in primiparae. Hammerschlag[6] found 95 per cent of uterine rupture in multiparae. Sheldon[4] found only two in primiparae among a total of twenty-six cases. All our cases of uterine rupture were in multiparae.

TABLE I
CASES OF UTERINE RUPTURE IN MULTIPARAE

No. of Deliveries	No. of Cases
2	1
3	2
4	2
6	2
8	1
9	2
10	2
Multiparae ?	1

As is well known the prognosis of uterine rupture is very serious to both mother and child. Out of thirteen cases we had six cases of maternal mortality or a mortality rate of 46.1 per cent. The mortality rate varies from 40 to 60 per cent, according to different authors. (Table II.)

* From the Department of Obstetrics and Gynecology, Hadassah University Hospital, Jerusalem.

	Table II Per Cent	
Hadassah Univ. Hosp.	46.1	
DeLee[5]	40	
Hammerschlag[6]	70	complete rupture
	50	incomplete rupture
Carton[7]	44	
Berkley, Bonney[8]	50 to 60	
Kupferberg[2]	45.8	
Sheldon[4]	42.3	

Fetal mortality reaches 90 per cent or more. We had 100 per cent fetal mortality. Only Sheldon gives a rate of 42 per cent.

In our material we had twelve cases of complete and one case of incomplete uterine rupture. Of our thirteen cases, eight cases were spontaneous uterine ruptures, three were violent ruptures and two on the border between violent and spontaneous, in connection with not very careful use of pituitary extracts.

Operations were performed in eleven cases (extirpatio or amputatio uteri supravaginalis). One patient died before the operation of acute anemia. One patient was not operated upon (the diagnosis of incomplete uterine rupture was made only one day after spontaneous delivery—the patient recovered).

Of the eleven patients operated upon, five died. Two of these were brought to the hospital in a severe general condition with all signs of uterine rupture (one died twenty minutes, the other forty-five minutes after operation). Of the other three fatal cases, one patient died five hours, another six hours after operation; the third died of embolus five days after operation.

In seven patients the uterine rupture occurred in the hospital, only one of whom died. The other six patients were admitted to the hospital with symptoms of threatened or actual uterine rupture; of these five died. From the above we may conclude that early diagnosis and operation are of utmost importance.

We have already mentioned that the prognosis is much better when the uterus is extirpated without first delivering the child per vias naturales. In six cases in which the child was delivered through the abdominal incision, only one ended fatally, while in the other seven cases, in which the child was first delivered per vagina and operation followed, five patients died.

The obstetric interventions in the last mentioned seven cases were: two embryotomies (neglected shoulder presentation), three forceps, one perforatio capitis, one combined version (suspected accidental hemorrhage). The operations were performed when the diagnosis of uterine rupture was not clear or when the presenting part was fixed on the pelvic floor.

In all textbooks the symptoms of threatened and actual uterine rupture are given in detail. Unfortunately, many of these symptoms are not observed. The theory of Bundle and his picture of uterine rupture are confirmed in the literature in a great number of cases. Nevertheless, there are cases in which the rupture occurred in connection with pathological changes in the uterine tissue, and the clinical picture obtained is thus completely different. Of the eight cases reported by Wlassow,[8] the symptoms according to Bundle were present only in one case; in the other seven cases the classical symptoms of threatened uterine rupture were absent. The same fact is reported by Vitzka.[9] One of our cases belongs also to this group.

Case 1. No. 44334, the patient, age thirty-five, was pregnant for the tenth time. According to the husband, the patient continued to work at home even after labor pains had started. In the middle of the work the patient fell down and fainted. When admitted to the hospital, the fetal heart sounds were not heard (in the differential diagnosis both uterine rupture and accidental hemorrhage had to be considered). Because of a five-finger dilatation we decided upon manual dilatation and combined version with manual extraction. The placenta was separated immediately after extraction of the child. This confirmed the diagnosis of accidental hemorrhage. Internal examination revealed uterine rupture on the left side. The patient died forty-five minutes after delivery before operation was begun.

In this case the fetus remained in the uterus, so that, besides the internal hemor-

rhage, no other signs of uterine rupture were present. Were it not for the tempting five fingers' dilatation, we would have operated upon this patient because laparotomy is indicated in both uterine rupture and accidental hemorrhage. We are unable to overcome the suspicion that the first complaint was accidental hemorrhage, and that the uterine rupture took place during the combined version.

Also in those cases in which uterine rupture was preceded by the symptoms given by Bundle, there were still many signs missing and the picture was confusing. The obstetric interventions made because of a not very clear diagnosis only brought the fatal outcome of the case nearer. The symptoms described by Bundle were present only in four cases. In these four cases all symptoms were present, while in the eight remaining cases there were deviations from the typical picture:

In one case (No. 40301) the patient, forty-two years old, delivered a dead child. A short time before delivery she complained of pain in the left side. This pain did not raise any suspicion of uterine rupture. Only after twenty-four hours, when an internal examination was made, an incomplete uterine rupture was detected at the height of the uteri internum. Since the patient felt well, a conservative attitude was taken. The patient suffered from parametritis and left the hospital after three months completely recovered.

In two other cases (No. 32866 and No. 10518) the rupture occurred a short time before delivery. In both cases the head was low and visible through the rima pudendi. Since there were fruitless pains outlet forceps was performed, and only after delivery did all pernicious symptoms of uterine hemorrhage caused by rupture appear. This fact was noted by DeLee[5] who says: "If the child has not been expelled into the abdominal cavity the pains may continue, though weaker, and they may, though rarely, suffice to deliver the child." This has also been noted by Hammerschlag.[6]

In two cases of neglected shoulder presentation in which some symptoms of threatened uterine rupture were present, it is possible that the rupture took place during embryotomy.

In one case (No. 29311) in which the child was delivered by high forceps, a violent uterine rupture may have occurred.

In the remaining two cases in which pituitary extract was used, the typical picture of rupture, according to Bundle's description, had not enough time to develop.

Although better results are obtained when the extirpation of the uterus is not preceded by any obstetrical intervention, we are, in many cases, obliged to intervene in one or another form. This occurs in cases in which the presenting part is low and the diagnosis of uterine rupture not yet clear (absence of signs of internal hemorrhage and persisting pains), in cases in which the diagnosis oscillates between uterine rupture and accidental hemorrhage, and a sufficient dilatation exists for termination of labor by an obstetrical intervention (No. 44334, mentioned above), and naturally in cases in which the diagnosis is made after obstetric intervention (violent rupture following high forceps and shoulder presentation).

SUMMARY

1. In the Obstetrical Department of the Hadassah University Hospital, Jerusalem, there were, during a period of ten years thirteen cases of uterine rupture among a total of 9,079 deliveries, i.e., an incidence of 1:698 or 0.14 per cent.

2. In spite of statistical data in the literature to the contrary, the number of cases decreased by half during the second part of the decade.

3. All thirteen cases occurred in multiparae.

4. Maternal mortality was 46.1 per cent (6:13). Fetal mortality 100 per cent.

5. We had eight cases of spontaneous rupture, three of violent rupture and two cases in connection with a not very careful use of pituitary extract.

6. Eleven patients were operated upon (uterine extirpation or amputation). One patient died before operation; one was not operated upon because the rupture was not diagnosed (patient recovered).

7. The uterine rupture took place in the hospital in seven patients, one of whom died. The other six patients were admitted to the hospital with signs of actual or threatened rupture; of these, five died.

8. The typical picture of uterine rupture, as given by Bundle, was present only in four cases.

9. In six instances operation was performed with no preceding obstetrical intervention; one of these patients died. In seven cases laparotomy was performed after obstetric intervention; five of these patients died. It thus follows that the prognosis is much better when laparotomy is not preceded by any obstetrical intervention. Unfortunately, in some cases, obstetrical intervention is unavoidable.

I am indebted to Prof. O. Zondek for permission to use the material of the Department.

REFERENCES

1. Stoeckel, W. Lehrbuch der Geburtshilfe. P. 521. Jena, 1930.
2. Kupferberg. Zur Uterusruptur. *Zentralbl. f. Cynäk*, 51: 758, 1927.
3. Wlassow. Die spontan ruptured. Uterus. *Zentralbl. f. Gynäk.*, 58: 1165, 1934.
4. Sheldon. A record of 26 cases of rupture of the uterus. *Am. J. Obst. & Gynec.*, 31: 455, 1936.
5. DeLee. Principles and Practice of Obstetrics. P. 852. Philadelphia, 1938. W. B. Saunders Co.
6. Hammerschlag, S. Lehrbuch der operativen Geburtshilfe. P. 378. Leipzig, 1924.
7. Corton, G. Notes sur les ruptures uterines observes a la maternite de Hanoi des 1930–1934. *Gynec. et Obst.*, 33: 366, 1936.
8. Berkeley, Bonney and MacLead. The Abnormality in Obstetrics. P. 240. London, 1938. Arnold.
9. Vitzka, A. B. Spontaneous rupture of the uterus during labour. *J. Obst. & Gynec.*, 127: 9–10, 1937.

PARTIAL GIANT GROWTH*

OPERATIVE REDUCTION IN SIZE OF A FOOT

ERNST BERGMANN, M.D.
NEW YORK, NEW YORK

MALFORMATIONS which take their origin in a faulty fetal anlage are characterized by their size, shape or in that the number of the component parts varies from the normal. In the first group congenital giant growth plays a modest rôle commensurate with its rarity.

One differentiates between genuine and false giant growth. It is considered genuine when all tissues are equally involved. In false giant growth one tissue is primarily or the only tissue involved. In this group are considered the congenital diffuse lymphangiomas which have been termed congenital elephantiasis by French authors (Kirmisson, Lannelongue).

Genuine giant growth can implicate the entire body, a body half, one extremity, hand or foot, single fingers or toes. Accordingly, one speaks of total or partial giant growth. With a certain regularity it appears that the excessive growth is more abundant the more peripheral the involved part. During the growth period the implicated part may either enlarge proportional to its original oversize or it can increase out of all proportions. In the latter case we speak of monstrosities. In all cases of giant growth one frequently finds abnormalities of the vascular system such as naevi, angiomas, ectasias and occasionally pigmentations.

FIG. 1. Before operation.

FIG. 2. After operation.

* From the Orthopedic Service of Bellevue Hospital, Arthur Krida, M.D., Director.

Giant growth, while considered congenital, has formerly not been considered hereditary. More recently a few cases were observed in which familial appearance was noted. This led to the conviction that one was dealing with a hereditary condition. The difficulties to prove the hereditary nature of this deformity are due to its rarity and its recessive character.

Beyond the general interpretation as faulty primary anlage there are several theories concerning its etiology. Some deal with nervous others with vascular anomalies.

Interference with function and cosmetic considerations determine the surgical indications. If one entire extremity is involved and the growth period not yet consummated, epiphyseal arrest by means of surgery or *x*-ray is of course the treatment to be contemplated. On the whole, one frequently has to take recourse to maiming procedures, amputations and disarticulations, particularly in dealing with a single enlarged finger or toe. If an entire hand or foot is involved, individual requirements have to be considered. In giant growth of the foot, for instance, we found the removal of the entire fifth metatarsal segment ("ray of the foot") to be a very useful procedure.

A sixteen year old girl whose family history was in no way remarkable complained that it was impossible for her to get a shoe which would fit her right foot. She stated that this foot has always been somewhat wider than the left one and that during adolescence the disproportion between the two feet increased considerably.

Fig. 3. Before operation.

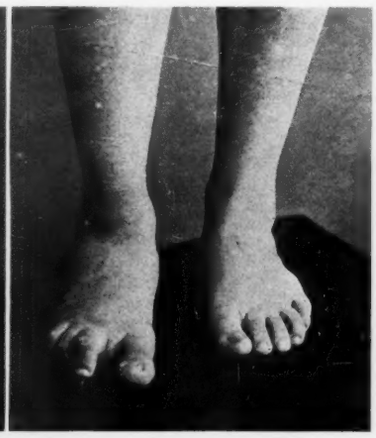


Fig. 4. After operation.

Examination revealed a foot which was markedly developed in width but only slightly longer than the left. In the enlargement soft parts and bones took an equal part. Both legs were equally long and the right calf slightly more developed than the left. All joints showed normal motion and there was no functional defect. As the only other asymmetry the right mammary gland was markedly enlarged, an observation which we have also noted in other cases of partial giant growth.

The patient insisted upon having both feet made the same size. To accomplish this, the removal of the lateral segment was obviously the best way.

Through a dorsolateral incision the fifth toe and metatarsal bone were exarticulated and the lateral part of the cuboid chiseled off, making it even with the base of the fourth metatarsal. The tendon of the peroneus longus muscle was preserved, the tendon of the peroneus brevis, having removed its insertion, was reanchored to the remains of the cuboid. The hypertrophied fatty tissue within reach of the incision as well as the short foot muscles of the fifth metatarsal were excised.

The patient made an uneventful recovery. Several months later she had no difficulty wearing normal foot gear. The patient was followed up well into her adult life. At no time did she complain of a functional disadvantage at the site of the operation.

THE USE OF THE TRANSFIBULAR APPROACH IN ARTHRODESIS OF THE ANKLE JOINT

THOMAS HORWITZ, M.D.
Instructor in Orthopedic Surgery, Jefferson Medical College
PHILADELPHIA, PENNSYLVANIA

THE purpose of this communication is to record the use of a surgical approach to the ankle joint in the performance of arthrodesis of this joint, which has been adopted from an approach advocated by Gatellier[1] and, more recently, by Alldredge[2] for the operative reduction of certain ankle fractures.

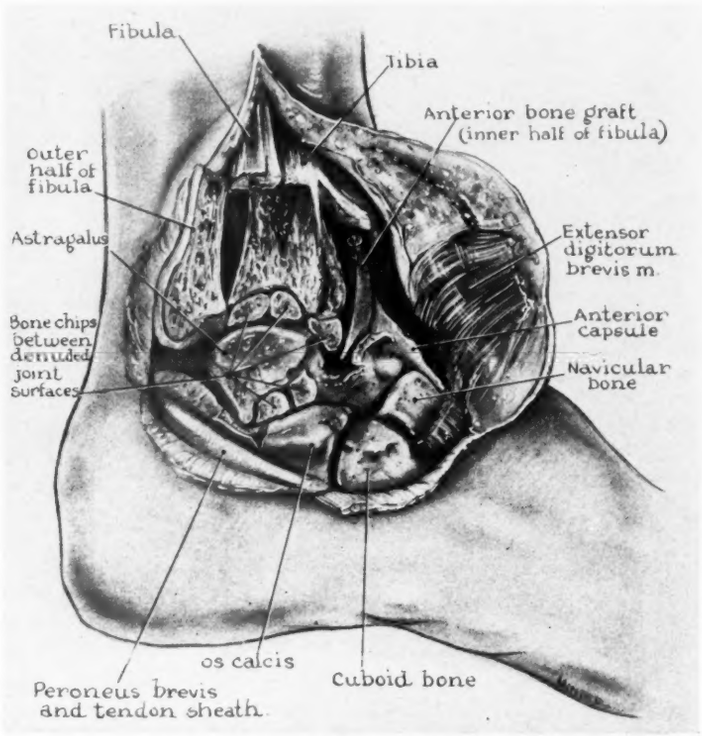


FIG. 1. Illustrating the use of the transfibular approach to the ankle joint, during panarthrodesis of the foot. The fibula has been osteotomized in its lower portion and the distal fragment has been reflected laterally. The subastragalar and midtarsal joints have been exposed through the same incision. The medial half of the reflected fibular fragment has been transplanted to bridge the anterior surface of the ankle joint, while bone chips have been introduced between the denuded articular surfaces. Upon closure, the lateral fibular fragment will be restored to its original position, where it will contact the denuded lateral surfaces of the tibia and astragalus.

Surgical fusion of the ankle joint is employed in the treatment of various destructive arthritides involving that joint, infectious or degenerative in origin; in the reconstruction of severe fractures about or involving the ankle joint, either as a primary or secondary procedure; and for the stabilization and correction of deformities of the ankle region and foot, as in infantile paralysis and certain congenital anomalies. Most operative procedures for securing ankle fusion, whether they be extra-

articular, intra-articular or combined extra- and intra-articular, utilize either an anterior, posterior, combined anterior and posterior or lateral approach. All of these approaches present certain inadequacies or undesirable features.

Fig. 2. Anteroposterior and lateral roentgenograms of the foot of a thirty-five-year old male, a few days after panarthrodesis for a paralytic flail foot with valgus deformity, secondary to a traumatic cord lesion.

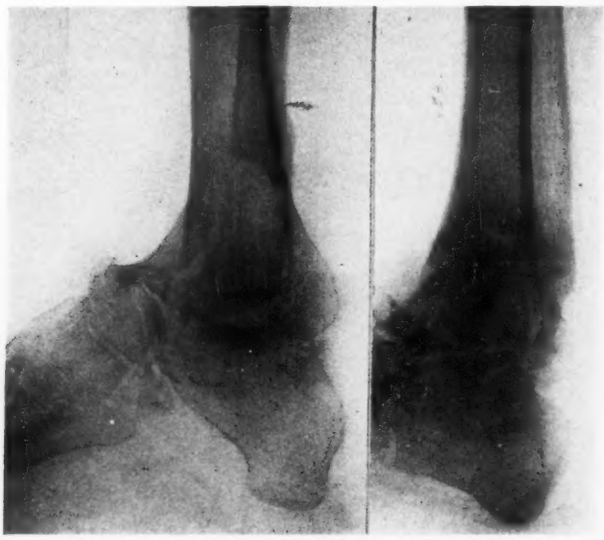
Fig. 3. Anteroposterior and lateral roentgenograms of the foot of a forty-five-year old male, a few days after arthrodesis of the false ankle joint following astragalectomy two years previously for a comminuted fracture of the astragalus. The resultant equinovarus deformity had been very disabling. The entire distal fibular fragment was used as a lateral graft to bridge the joint after the latter had been denuded and filled with bone chips.

The transfibular approach, utilized by the writer, combines two principles: (1) osteotomy of the fibula as advised by Goldthwait[3] to insure accurate coaptation of all denuded surfaces between the astragalus and ankle mortise, and (2) the approach of Gatellier[1] who exposed the ankle joint by freeing the lower portion of the fibula and turning it downward, the external lateral ligaments acting as a hinge.

Operative Procedure. The skin incision runs along the posterior border of the lower 10 cm. (4 inches) of the fibula and, just below the tip of the external malleolus, swings forward to end over the cuboid bone. The peroneal tendons are exposed and retracted posteriorly or divided. The fibula is osteotomized about 7.5 cm. (3 inches) above the tip of the malleolus and this lower fragment is reflected laterally, leaving only its posterior attachments intact. The ankle joint is further exposed, especially anteriorly, by additional soft tissue stripping. When a panarthrodesis is to be performed, the soft tissues are dissected from the bone on the lateral surface of the foot to expose the subastragalar, calcaneocuboid and astragaloscaphoid articulations. (Fig. 1.)

Following denudation of the joint surfaces the reflected distal fibular fragment is returned to its original position. The writer has pursued the following technic: After denudation of the articular cartilage from the joint surfaces and the insertion of numerous bone chips, the reflected fibular fragment is split longitudinally, the medial half being used as a free bone graft across the ankle joint anteriorly, and the lateral half being reapplied to the denuded lateral surfaces of the tibia and astragalus. (Fig. 1.) When the subastragalar joint is

also being ankylosed, the lateral fibular portion may be freed further and shifted downward to span both the ankle and subastragalar joints. The attachment of the fibular fragment is secured by heavy catgut sutures. The position of the foot and the need for correction of any residual deformity by manipulation or cast-wedging are determined by postoperative roentgenographic study.



a *b*

FIG. 4. *a*, lateral roentgenogram of the hindfoot of a seventeen-year old male, three months after panarthrodesis for a paralytic calcaneovalgus deformity, following acute anterior poliomyelitis. *b*, lateral roentgenogram of the hindfoot of a fourteen-year old male, three months after panarthrodesis for a severe congenital equinovarus deformity with disturbed distal tibial epiphyseal growth.

The transfibular approach has been employed by the writer for the surgical fusion of the ankle joint in five cases. (Figs. 2, 3, 4*a* and 4*b*.) It should not be used in young subjects, except in selected cases (Fig. 4*b*), because of the danger of disturbing normal epiphyseal growth.

CONCLUSIONS

The transfibular approach simplifies the exposure of the ankle joint for arthrodesing purposes by obviating the necessity for wide soft-tissue dissection and distorsion of the foot, and it assures complete bony contact of all of the denuded articular surfaces.

REFERENCES

1. GATELLIER, J. The juxtoretroperoneal route in the operative treatment of fracture of the malleolus with posterior marginal fragment. *Surg., Gynec. & Obst.*, 52: 67–70, 1931.
2. ALLDREDGE, R. H. Diastasis of the distal tibiofibular joint and associated lesions. *J. A. M. A.*, 115: 2136–2140, 1940.
3. GOLDTHWAIT, J. E. An operation for stiffening of the ankle joint in infantile paralysis. *Am. J. Ortho. Surg.*, 5: 271–275, 1908.

PATHOGENESIS OF ARTHRITIS FOLLOWING THE INTRAVENOUS INJECTION OF STAPHYLOCOCCI IN THE ADULT RABBIT*

R. H. RIGDON, M.D.
Associate Professor of Pathology, University of Tennessee
MEMPHIS, TENNESSEE

THE incidence of staphylococci as the causative agent of pyogenic infections of bones and joints is high. The pathogenesis of these lesions is not always clear either from an experimental or clinical standpoint.

Osteomyelitis usually occurs in young rabbits following the intravenous injection of Staphylococcus aureus. Experimental studies[1,2] show that when this organism is given intravenously to young rabbits it localizes in the capillaries of the metaphysis of the long bones and abscesses subsequently develop. The infection gradually extends to the adjacent tissues. Thompson and Dubos[3] observed that the infection extended from the end of the long bones into the joints in only eight out of forty-seven cases of osteomyelitis. Kistler[4] found that all healthy growing rabbits receiving living cultures of staphylococci intravenously and surviving the septicemia for more than two days, develop marked exudative arthritis in one or more joints with destruction of the articular cartilage and subchondral bone. Lexer[5] states that adult rabbits develop a suppurative arthritis following the intravenous injection of staphylococci. From the studies of Kistler, Lexer and Thompson and Dubos it appears that both osteomyelitis and arthritis may occur in growing and adult rabbits following the intravenous injection of staphylococci.

The present paper is a study of the pathogenesis of purulent arthritis in the adult rabbit following the intravenous inoculation of a broth culture of Staphylococcus aureus. The articular lesions are observed in three groups of rabbits: First, in the normal; second, animals previously immunized with staphylococcic toxin; and third, rabbits given staphylococcic antitoxin.

The larger joints are observed macroscopically. Roentgenograms are made at frequent intervals. Bacteriological and pathological examinations are made on the joints after they have been infected for different periods of time.

The arthritic lesion following the intravenous injection of a broth culture of Staphylococcus aureus is compared with the local lesion that follows the intra-articular inoculation of the knee joints with the same bacterium.

EXPERIMENTAL

Rabbits vary in their susceptibility to staphylococci and staphylococcic toxin. This is thought to be the result of natural immunity. In view of this, the following procedure is carried out to determine the approximate lethal dose of the culture of Staphylococcus aureus used in the following three groups of rabbits: Group 1, normal rabbits; Group 2, those immunized with staphylococcic toxin; Group 3, animals given the same quantity of a broth culture of Staphylococcus aureus and the period of survival is observed. The strain of staphylococci used in these experiments was isolated from a patient who died with agranulocytic angina. It has been used in other experiments.[6–7]

Nine rabbits in Group 2 are given twelve intravenous injections of staphylococcic toxin over a period of one month. The day following the last injection the

* This experimental work was carried out in the Department of Pathology at Vanderbilt University.

animals are given 4 cc. of a twenty-four-hour broth culture of staphylococci. Five rabbits in Group 3 are injected with 1,750 units of staphylococcic antitoxin* and four hours later they are injected with 4 cc. of the same bacterial suspension. Five rabbits in Group 1 are used for the controls. The following data show the time of death of the rabbits in the three groups:

Immunized with Staphylococcic Toxin		Given Staphylococcic Antitoxin		Normal	
No.	Results	No.	Results	No.	Results
100	Killed after 26 days	111	Died after 20 hrs.	112	Died after 20 hrs.
102	Died after 60 days	113	Died after 92 hrs.	114	Died after 56 hrs.
103	Died after 8 days	115	Died after 27 hrs.	116	Died after 20 hrs.
104	Died after 14 days	117	Died after 56 hrs.	118	Died after 20 hrs.
105	Died after 11 days	119	Died after 127 hrs.	120	Died after 20 hrs.
106	Died after 11 days				
108	Killed after 28 days				
109	Died after 96 hrs.				

The period of survival of the rabbits in the three groups is too short to compare the frequency of the development of joint lesions. It appears advisable in subsequent experiments to compare the lesions in rabbits immunized with staphylococcic toxin and given the same number of staphylococci with one group of normal animals and the pathological changes in rabbits given staphylococcic antitoxin and a different amount of the inoculum with another group of normal animals.

ARTHRITIS IN THE NORMAL RABBIT FOLLOWING THE INTRAVENOUS INJECTION OF A BROTH CULTURE OF STAPHYLOCOCCUS AUREUS

Four adult rabbits were given a single intravenous injection of a broth culture of Staphylococcus aureus. Two of these died twenty-four hours later. A third died after forty-eight hours and the fourth was moribund at this time and was killed.

A bacteriological examination was made on one of the two rabbits that died after twenty-four hours and on the one killed after forty-eight hours. A small amount of blood tinged fluid was present in the left knee of the former and in both knee joints of the latter. Gram-positive cocci were cultured from this fluid. This bacterium gives the same fermentation reaction as the organism isolated from the heart's blood, and also the same as that of the original inoculum.

Six normal adult rabbits were given 2.0 cc. of the same culture of staphylococci. One animal died after twenty-four hours and two after forty-eight hours. Two other rabbits developed a purulent arthritis, one in both knees and the other in only the right knee. One rabbit was normal after thirty days and was discarded. The animal with arthritis in the right knee was observed over a period of approximately six months during which time roentgenograms were made at frequent intervals. Two blood cultures taken during this period were sterile.

A second group of five rabbits was given a smaller number of staphylococci on each of the following days: first, eighth, nineth and twelfth. One rabbit in this group died on the seventeenth and another on the twentieth day of the experiment. Neither of these two animals showed any gross pathological changes in the larger joints. Three rabbits were normal after thirty days and were discarded. A blood culture was sterile from one of these when they were discarded.

The above observations show that staphylococci, when injected intravenously reached the joint cavity within a period of twenty-four hours. The blood stream may subsequently become sterile and the rabbit live for six months with an active lesion in the joints. When the inoculum is small, either the bacteria do not localize in the

* The antitoxin was supplied by Lederle Laboratories.

joints' cavities or the local resistance is sufficient to prevent the production of a lesion.

It is interesting to observe the absence of osteomyelitis in any of the fifteen rabbits used in these experiments.

ARTHRITIS IN RABBITS IMMUNIZED WITH STAPHYLOCOCCIC TOXIN AND GIVEN A BROTH CULTURE OF STAPHYLOCOCCUS AUREUS INTRAVENOUSLY

Five rabbits were immunized with staphylococcus toxin. Three series of intravenous injections of the toxin were given during a period of approximately five months. Six days after the last injection of the toxin the animals were given intravenously a broth culture of staphylococci. One rabbit died four days later and another developed purulent arthritis in the left elbow. This joint was macroscopically normal forty-five days following the inoculation of the bacteria. Roentgenograms at this time showed only a slight periarticular swelling. Three of the rabbits did not show any lesion during a period of thirty days.

Five normal rabbits were used as controls. Every animal died within forty-eight hours after the bacteria were injected.

A second group of eight rabbits were immunized over a period of one month and then given intravenously a broth culture of staphylococci. One animal died in less than four days. Seven lived for eight days or longer and three of these developed macroscopic arthritis in one or more of the larger joints. Two of the rabbits with arthritis were killed twenty-six days following the inoculation of the bacteria. Both knees, the left elbow and the right shoulder in one rabbit were filled with caseous material. Smears of this exudate show leucocytes and Gram-positive cocci which are considered to be staphylococci. The third rabbit with arthritis was killed after approximately two months. A smear and culture from the exudate in one of the knee joints showed the same bacterium as described above. The culture from the heart's blood was sterile. The joint lesions were followed at frequent intervals with roentgenograms and pathological studies were subsequently made on the tissues.

Five normal rabbits in the control group were given the same volume of the broth culture of staphylococci. All were dead in less than fifty-six hours.

The roentgenological and pathological changes in this group of rabbits given a series of injections of staphylococcic toxin are the same as those that occur in normal rabbits following the intravenous injection of staphylococci.

ARTHRITIS IN RABBITS GIVEN STAPHYLOCOCCIC ANTITOXIN AND BROTH CULTURES OF STAPHYLOCOCCUS AUREUS

The effect of staphylococcic antitoxin on rabbits given broth cultures of staphylococcus aureus has been reported.[8] The length of the survival period following the intravenous injection of staphylococci is influenced by the amount of antitoxin given and the time elapsing between the injections of the organisms and the antiserum.

Seven rabbits were given multiple injections of staphylococcic antitoxin and then a single intravenous injection of a broth culture of staphylococci. One animal died twenty-four hours later and another lived for seven days. Four rabbits developed purulent arthritis. One was normal thirty days after the inoculation and was discarded. A rabbit with arthritis in the right and left elbow was killed on the fourth day of the experiment. Another with a swelling of each knee and the right elbow was killed on the eighteenth day. Smears and cultures from the material in the joints of the latter rabbit showed a Gram-positive coccus which is considered to be a staphylococcus. A culture of the heart's blood was sterile. Roentgenograms and pathological studies were made on these rabbits.

Six rabbits were in the control group. All were dead in less than forty-five hours following the injection of the bacteria.

A second group of four rabbits was given multiple injections of staphylococcic antitoxin and two inoculations of a broth culture of Staphylococcus aureus on consecutive days. All the animals developed purulent arthritis. Smears and cultures from the material in the joints showed a Gram-positive coccus which was considered to be a staphylococcus. The blood from the heart of two rabbits taken on the tenth and thirteenth days of the experiment was sterile. A staphylococcus was isolated from the blood of the third rabbit on the fourteenth day following the injection of the bacteria.

Four animals in the control group receiving the same amount of the broth culture of staphylococci were either dead or moribund forty-eight hours later.

Lesions developed in the joints following the intravenous injection of staphylococcus in the rabbits give staphylococcic antitoxin the same as in the nonimmune rabbits. No primary lesions were observed in the bones.

CLINICAL OBSERVATIONS

The macroscopic changes are essentially the same in these three groups of rabbits. The number of infected joints vary. The larger joints in the extremities begin to swell approximately five days following the intravenous injection of the broth culture of staphylococci. The rate at which the swelling progresses varies in different rabbits. The skin over the swollen joints does not appear abnormal.

The swelling is localized to the joints in the early stages of the infection. As the inflammation progresses the contour of the joints frequently becomes irregular and the adjacent tissues swell. The joints are rubbery in consistency when they reach their maximum size. The bones in some of the joints can be moved at this time and frequently a grating sensation is noted. This grating is the result of erosions in the articular cartilage. While the joints are swollen the rabbits attempt to keep the extremity at rest. The swelling usually increases for two to three months and then gradually decreases during the following two to three months. The joints usually remain larger than normal.

Three rabbits with arthritis were followed for approximately seven months. The function of the knee joints in two of these was apparently only slightly impaired after six months. The amount of movement and the grating sensation obtained when the articular surfaces of opposite bones are rotated on each other decreases considerably by the fifth to the sixth months.

The rabbits frequently lost weight following the injection of staphylococci especially those animals with multiple joint involvement. The weight is usually also slightly below normal in the rabbits in which only one joint is infected over a long period.

ARTHRITIS IN THE NORMAL ADULT RABBIT FOLLOWING THE INTRA-ARTICULAR INJECTION OF STAPHYLOCOCCI

Macroscopically the lesions in the knee following the intra-articular injection of staphylococci are similar to the process that follows the intravenous inoculation of the same organism. The bacteria are injected through a No. 27 gauge needle into the cavity of the knee joints. The needle is passed through the petella. The swelling in the joints and the adjacent tissues are more marked in this group of rabbits than in those animals given the bacteria intravenously. Blood cultures from five of the rabbits taken eight days after the intra-articular injection of staphylococci were sterile. Bacteria considered as staphylococci were isolated from the exudate in the knee joints of two of these animals.

ROENTGENOLOGICAL EXAMINATIONS*

The roentgenological changes observed in the joints following the intravenous

* The roentgenological interpretations were made by Dr. H. C. Francis of Vanderbilt University. I wish to thank Dr. Francis and the Department of Roentgenology for co-operating in this study.

inoculation of broth cultures of staphylococci, like the pathological vary slightly in the different animals. The general process, however, is always the same. During the first two to three weeks the roentgenograms show only periarticular swelling. After this time the articular surfaces of the tibia and femur appear slightly rough. This change progresses in some of the rabbits until there are small focal areas of bone destruction which extend down into the epiphysis. Accompanying this chance is a condensation of the ends of the bones. Some of the joints after two to three months show an atrophy of the periarticular tissues, a decrease in the space between the articular surfaces of the bones and a proliferative reaction. A few of the animals with extensive involvement of a joint for six months or longer show some evidence of what appears to be a beginning ankylosis. (Figs. 1, 2 and 3.)

Periarticular swelling is the first change observed in the posterior extremities of rabbits following the intra-articular injection of broth cultures of staphylococci. A rough articular surface subsequently develops. It progresses until an extensive destruction of the adjacent bones occur with a diminution in the space between the femur and tibia. Proliferation of bone and ankylosis of the knee joint may develop after three to four months.

There is nothing in any of the roentgenograms to suggest either a primary osteomyelitis, epiphysitis or periostitis in the rabbits receiving the broth cultures of staphylococci either intravenously or directly into the joint cavity.

The pathological changes which occur in the knee joints of rabbits receiving broth cultures of staphylococci intra-articularly are similar to the lesions that develop in the joints following the intravenous injection of the same organism. The extent of injury is much greater, however, in the former group. Calcification and ankylosis also occur more frequently in the group of rabbits given the bacteria directly into the joint space.

PATHOLOGICAL STUDY

Swelling of the larger joints is usually detected three to five days following the intravenous injection of staphylococci. This swelling gradually increases for approximately two months. The joints at this time are rubbery in consistency. The swelling slowly decreases. The knee joints of the animals that live for three months or longer apparently never returned to their normal size.

Some of the joints examined during the first forty-eight hours contain a small amount of blood-tinged fluid. Staphylococci are frequently demonstrated in the cultures, the smears and in the histological sections removed from these early lesions. During the first forty-eight hours the periarticular tissues may become edematous. Abscesses frequently occur in the muscles and viscera. The earliest histological change observed in any joint is a perivascular infiltration of leucocytes in the fat pads in the knee. This animal died seventeen hours after the intravenous injection of staphylococci. The earliest macroscopic lesion observed in a joint occurred in the right knee of a rabbit forty-eight hours after the intravenous inoculation of the bacteria. There was a small amount of bloody fluid in this joint; the fat pads were hemorrhagic. Polymorphonuclear leucocytes and endothelial-like cells infiltrate the synovial membrane and a purulent exudate was present on the surface. The synovial cells were fragmented and pyknotic. The capsule of the joint was edematous. It was infiltrated with red blood cells, polymorphonuclear leucocytes and mononuclear cells. A section of this capsule showed Gram-positive cocci in the lumen and in the wall of some of the capillaries. Groups of similar bacteria were present in the interstitial tissue and between the cells in the areas of the cellular reaction. Gram-positive cocci were present in the cytoplasm and apparently were sticking to the surface of leucocytes and other cells which resemble those lining the

synovial membrane. These bacteria are considered to be staphylococci. Many of the tissue cells in the area of the bacteria showed evidences of injury.

this time the contents of many of the joints had dissected outward along the tendon sheaths and lay in large masses between groups of muscles.

Fig. 1. The roentgenograms are made on the following days after the staphylococci are injected intravenously. From left to right, control showing left knee. Right knee after 130, 260 and 327 days. After 130 days there is beginning destruction of the medial cartilage. The intercondylar groove of the femur is deeper than normal. In the third picture there is complete destruction of the medial cartilage. The articular surfaces of the femur and tibia are eroded. After 327 days the erosion has progressed. There is some bone destruction and beginning bony ankylosis.

Fig. 2. The roentgenograms are made on the following days after the staphylococci are injected intravenously. From left to right, 18, 25, 123 and 186 days. There is no definite pathological change observed after eighteen days; however, on the twenty-fifth day there is some narrowing of the joint space and a beginning erosion of the intercondylar groove. The outer margin of the medial condyle of the femur shows some erosion. The processes are progressing and on the 123rd day the medial cartilage is almost completely destroyed. There is some sclerosis of the bone above the articular areas involved. There is a further exaggeration of the above processes on the 186th day. The decalcification present at this time may have resulted from disuse of the joint.

The exudate in the joint cavities gradually increased and the capsule became more diffusely infiltrated with inflammatory cells. After approximately one month the joints were filled with a thick, yellowish-gray, caseous material and the synovial membrane was completely destroyed. By

The articular cartilages in the infected joints were smooth and grossly normal during the first ten days of the experiment. They are frequently eroded, however, by the twenty-sixth day. This lesion apparently served as a route for the bacteria to reach the epiphysis. Figure 4 shows the

Fig. 3. The roentgenograms are made on the following days after the staphylococci are injected intravenously. From left to right, 35, 89, 117 and 180 days. There is some decalcification about the joint in the first picture. In the second there is beginning erosion of the lateral border of the medial femoral condyle and a deepening of the intercondylar groove. The third shows that the erosion is progressing. There is some destruction of the bone above the intercondylar groove. The joint space is narrower. These pathological processes are progressing as shown by the last plate.

Fig. 4. This rabbit is injected intravenously with a broth culture of staphylococci and killed seventy days later. The extremity is examined by *x*-ray on the following days after the bacteria are injected: 32, 40, 48, 55 and 68 days. At this time the epiphysis is secondarily involved and the infection has extended down into the shaft of the tibia.

articular surface of the tibia in a rabbit that died two months after receiving an intravenous injection of staphylococci. The greater part of the articular cartilage in this animal is eroded and the epiphysis is destroyed in focal areas by a necrotizing process which extends down to the epiphyseal line.

The rabbits that survived the staphylococcic infection for five to six months showed the infected joints to be slightly larger than the normals. There usually was a little purulent exudate in the joints even at that time. The synovial membranes were smooth and glistening. The articular cartilages in rabbits with a purulent arthritis showed a moth-eaten surface similar to that observed in infected joints after the first month of the infection.

DISCUSSION

The observations made in this study on the pathogenesis of purulent arthritis in the adult rabbit show that staphylococci localize in the joints within twenty-four to forty-eight hours after the intravenous injection of a broth culture of the organism. The bacteria isolated from the articular lesions are the same strain as those injected. The presence of an acute inflammatory reaction and the demonstration of bacteria both by cultural methods and in the tissues indicate that staphylococci pass through the blood stream directly to the synovial membranes. The inflammatory reaction progresses until the joint cavity is filled with a purulent material. The articular cartilage is eroded after being in the presence of this exudate for approximately two to four weeks. Bacteria apparently may invade the epiphysis secondarily through the perforations in the cartilage and may extend down into the epiphysis.

The localization of staphylococci in the joints apparently cannot be considered the results of any special affinity of this strain of staphylococci for synovial membranes. These organisms produced abscesses in muscles and viscera in the same rabbits that develop purulent arthritis. There appears to be insufficient evidence at the present time to consider any strains of staphylococci specific for bone. It is suggested that lesions may develop where even staphylococci may localize. The development of a lesion, of course, is influenced by the number of bacteria, their virulence and the local and systemic immunity.

In a previous study it was shown that staphylococcic antitoxin either completely inhibits or delays the time at which death occurs in rabbits receiving intravenously broth cultures of staphylococci.[8] It is suggested that when death does occur before forty-eight hours it may be the result of the action of the staphylococcic toxin which had been produced *in vivo*. Staphylococcic antibodies in both the actively and passively immunized animal apparently neutralize staphylococcic toxin.

It is impossible at this time to compare the frequency of purulent arthritis in the three groups of normal and active and passively immunized rabbits. Apparently the immunized animals survive the lethal effects of this culture of staphylococcus through their ability to neutralize the toxin liberated by this bacterium *in vivo*. The organisms reach the joints through the blood and also may produce an inflammatory reaction in the adjacent soft tissues. The frequency and the number of joints involved apparently are influenced by the number of bacteria circulating in the blood.

The pathogenesis of the purulent arthritis which follows the intravenous inoculation of staphylococci in this group of adult rabbits is different to that which has been described in young rabbits. In the former the bacteria pass directly through the blood stream to the synovial membranes. In the latter, they localize in the metaphysis and may subsequently pass into the joint cavity.

The arthritis which develops following the intravenous inoculation of staphylococci in the adult rabbit is always similar to the lesion which follows the intra-articular injection of the same organism into the knee joints of adult rabbits.

SUMMARY

The pathogenesis of the purulent arthritis following the intravenous injection of a broth culture of Staphylococcus aureus into the adult rabbit is discussed. It is suggested that the bacteria pass directly through the blood stream to the synovial membranes. The articular cartilage is eroded subsequently to the formation of the purulent exudate. Staphylococci may invade the epiphysis secondarily through the erosions in the articular cartilage.

The number of joints involved and the frequency of arthritis in the normal and immune rabbit apparently is influenced by the number of bacteria circulating in the blood stream.

The arthritis which develops following the intravenous inoculation of staphylococci is similar to the lesion that occurs after the intra-articular injection of the same organism.

There is apparently no association between the strain of staphylococci used in this study and the development of lesions in bone. It is suggested that there is insufficient evidence at this time to warrent a classification of "osteomyelitic strains of staphylococci."

I wish to acknowledge my appreciation to Dr. Hillyer Rudisill, Assistant Professor of Radiology, University of Tennessee, who reviewed these *x*-rays with me and helped to prepare the illustrations.

REFERENCES

1. Hobo, T. *Acta scholae med. univ. imp. in Kioto*, 4: 1, 1921–1922.
2. Robertson, D. E. *J. Bone & Joint. Surg.*, 9: 8, 1927.
3. Thompson, R. H. S. and Dubos, R. J. *J. Exper. Med.*, 68: 191, 1938.
4. Kisler, Gene R. *Proc. Soc. Exper. Biol. & Med.*, 34: 829, 1936.
5. Lexer, E. General Surgery. New York, 1910. D. Appleton & Co.
6. Rigdon, R. H., Joyner, A. L. and Richetts, E. T. *Am. J. Path.*, 10: 425, 1934.
7. Rigdon, R. H. and Freeman, P. R. *J. Lab. & Clin. Med.*, 25: 1125, 1940.
8. Rigdon, R. H. *J. Lab. & Clin. Med.*, 23: 159, 1937.

POSTOPERATIVE INFECTION*

ITS CONTROL BY SURGICAL TECHNIC

JOSEPH L. DE COURCY, M.D.
CINCINNATI, OHIO

MEDICINE and surgery have come a long way since Semmelweis in 1847 to 1849 showed that infection can be carried on presumably clean hands. His principles, modified by newer knowledge, still remain the basis of modern aseptic surgery. But even with our advanced state of information, the incidence of postoperative infection is far too great.

It is generally estimated that from 3 to 5 per cent of all cases of surgical intervention with clean wounds are followed by postoperative infection. But not so many years ago, Meleney[1] observed that, if the operators rather than interns attended to removal of the stitches from the wounds, they would lose much of their false sense of security. He estimated that not 5 per cent but about 15 per cent of clean wounds become infected.

This figure is undoubtedly much higher than the present rate of postoperative infection, for we have improved our surgical technic and have learned more about the causes of such infections during the last few years. However, it is my opinion that the occurrence of infection in a clean wound can be reduced even further. It has always seemed to me that, as in all fields of modern medicine, the answer lies in prophylaxis rather than in later attempts at cure.

At the De Courcy Clinic we have lessened postoperative infection by adherence to four simple principles, namely, (1) the avoidance of contact with pus, (2) gentle handling of tissues, (3) care in the use and tying of sutures and ligatures and (4) reduction of operating time to a minimum consistent with good operative technic.

Instruments should be substituted for the hands whenever possible when handling pus or an infected wound. Unlike the hands, instruments, ligatures, gauze and all other similar objects coming in contact with the field of operation can be absolutely sterilized. Bacteria-contaminated materials of this type are almost unforgivable with the available methods of sterilization and disinfection. Proper care can eliminate instruments completely as a source of postoperative infection.

Surgeons have come to learn that gloves are not always dependable sources of protection, either for the operator or for the patient. In England, two years ago, when tracing down the source of Staphylococcus aureus postoperative infections, Devenish and Miles[2] found that punctured surgical gloves are a very common occurrence. Leaks were present in 24 per cent of 6,585 patched and unpatched rubber gloves. Even during a period when special care was taken to avoid punctures, holes appeared in over 14 per cent of the gloves. In a few instances, the punctures were discovered as soon as they were made; but in most cases the holes were found only at the end of the operation when tests were performed. By this time there had been ample opportunity for leakage.

The search narrowed down to two surgeons who performed most of the operations in this hospital. Though both were carriers of a virulent strain of Staphylococcus aureus, only one carried such organisms on his hands. His were the cases in which postoperative infections appeared. Tests showed that these bacteria passed not only through leaks in his gloves but

* From the Department of Surgery, De Courcy Clinic, Cincinnati.

also via the sweat through the sleeves of his coarse linen operating gown. The institution of suitable precautionary measures was followed by disappearance of the sepsis.

Very recently Hirshfeld[3] checked the gloves in the operating rooms in the hospital with which he is associated. He found a puncture incidence of 18 per cent in 429 gloves. In most cases, the members of the operating team did not realize that their gloves had been torn. He cultured gloves which had been worn for various periods of time and found that the number of organisms recovered varied from 1000 to over 1,000,000, depending upon the individual, the amount of perspiration in the glove and the length of time it had been worn.

This result clearly demonstrated that an enormous number of organisms may escape from a torn glove in a drop of sweat. The hazards presented through torn gloves is even more evident when it is remembered that the gloves worn by most surgeons are extremely thin and delicate.

In addition to these hazards, recent work (McCormick and Ramsey[4]) indicates that lycopodium powder or talc, used on the hands and gloves preceding operative procedures, forms another potential danger factor. When introduced into the tissues from the gloves of the surgeon or of his assistants, either or both of these powdered materials may produce an inflammatory reaction of the granulomatous type.

We cannot, however, depend too much upon the preoperative scrub-up procedure. Much has been written about disinfection of the hands before operating, yet no fully satisfactory method has been developed. All surgeons are conscientiously trying to improve their technic, but many believe that the ten-minute scrub is not only not the answer but in many instances is actually harmful. Anyone who has had to scrub-up several times each day will appreciate what I mean.

The ultimate aim, of course, is to make the hands and forearms practically free from pathogenic organisms before operating, because, as I have indicated, gloves are not always dependable. However, practical considerations show that such sterilization is impossible. By scrubbing we can hope only to remove the gross dirt from the hands and arms. The sweat glands and the skin follicles cannot be reached. Disinfectants cannot kill germs without some injury to the normal protective surfaces of the hands.

Yet the essential purpose of thorough preoperative washing cannot be minimized. It has been found that the organisms which remain on the skin after scrubbing multiply rapidly under rubber gloves (Hirshfeld[3]).

In my opinion, vigilant prophylaxis is the answer and avoidance of contact with pus is a most important part of such prophylaxis. If the surgeons' hands and the hands of their assistants never come in contact with pus, the chances are that the glands and follicles of the skin will be free of pathogenic organisms. In fact, a surgeon once remarked to me that he would rather have a carpenter come down off a roof and, after washing the gross dirt off his hands, put his hand in his abdomen than he would a surgeon who had recently handled a pus case with his own hands and then scrubbed them for ten minutes.

This may seem far fetched, but I believe that it is the answer to clean surgery. Indeed, it has been shown that, if the skin is constantly exposed to certain organisms, these bacteria eventually become part of the skin's resident flora (Price[5]).

I have always made it a policy never to dress an infected wound without wearing gloves and then never to touch the pus with the gloved hand unless it is absolutely necessary, as when operating for a ruptured appendix or the like. I have always used instruments to handle the dressings and I have taught this practice religiously to students and nurses with whom I have come in contact. This procedure and the reasons for it should be taught to interns as

soon as they enter their hospital period. The technic is easily acquired and after a time one begins to dread pus as he would the plague.

Gentle handling of tissues is another requisite if postoperative infection is to be reduced, but here, too, instruments should be used rather than the hands. Avoidance of direct handling of the tissue as far as is possible and a delicate atraumatic technic are the marks of an able surgeon. It is obvious that overmanipulation of the tissues readily results in trauma and lowered resistance to local infection.

Let instruments, which can so readily be disinfected, serve in place of the fingers. The most important instrument for handling tissue, in my opinion, is the mouse-toothed forceps. In doing many operations, in most appendectomies and herniotomies, my fingers and those of my assistants never touch the tissues.

Use of as fine catgut as is consistent with strength is also an important part of surgical prophylaxis against postoperative infection. Suturing materials of larger diameter may offer certain manipulative advantages without contributing additional strength to the wound and should be avoided. Such sutures produce an excessive quantity of foreign body in and about tissue that should be given every opportunity to heal quickly and cleanly. Thicker sutures not only predispose to delayed wound healing but also to infection.

Finer catgut sutures also permit more accurate approximation of the wound edges, with less tendency to trauma, with better hemostasis and with more freedom from possible reaction. Knots are also more secure with finer suturing materials. However, the knots should not be tied too tightly. Knots should be tied artistically rather than as by one doing a trade, but too much time should not be incorporated in a tie.

If the principles previously outlined are scrupulously adhered to, it will not matter in our final results whether we use catgut or silk. Though not all surgeons will agree with my choice, I still prefer catgut because it makes for a quick technic and because, normally, in spite of all precautions, a slight infection will occasionally result. If an infection does result after using silk, sinuses may develop in the wounds and they will not heal until the silk is removed or expelled. Such sinuses frequently persist for months. I have frequently seen such cases in which operations were performed by men who preferred to use silk. Nylon sutures offer interesting potentialities, but their introduction is too recent for sufficient accurate clinical data to have been accumulated.

In my experience, another cause of postoperative infection has been long operations. By long operations, I mean those lasting over one hour. Operations lasting three to five hours are not unusual today. The average operation, as for thyroidectomy, appendectomy, hysterectomy, gastroenterostomy and the like, should never exceed one hour. Gastrectomy sometimes requires one hour and a half, but I fail to see what surgeons can do for six hours in any of these cases. I am not prepared to speak for brain operations but these surgeons seem to be the greatest offenders.

If our surgical predecessors of preanesthetic days taught us anything, they taught us the value and importance of speed and dexterity in surgical procedures. Perhaps it might be a good thing for surgery in general if more of the modern operators claimed their share of this heritage. Unfortunately, the drain of unusually long-drawn operations upon the strength of the patient is too frequently reflected in postoperative shock and slow recovery. Nor must we forget that the longer the patient is upon the operating table, the greater the chances of infection. It has been shown that the number of bacteria that can be recovered from the skin increases as the length of an operation increases (Ives and Hirshfeld[6]). Moreover,

the strain upon the nerves of the surgeon during an excessively long operation is incalculable. Such strain necessarily impairs his technic.

I should like to comment briefly on certain recent, though not fully evaluated, developments that may have some influence in preventing postoperative infection. I refer to the revival of Lister's idea that the air of operating rooms should be rendered as sterile as possible. Lister employed phenol sprays, but today germicidal aerosols and irradiation by ultraviolet light are employed for atmospheric sterilization. Aerosols, which are antiseptic mists against airborne organisms, are still very much in the experimental stage and evidently not widely used in operating rooms (Robertson et al.[7]).

Considerable attention has been given to the employment of bactericidal radiant energy and enthusiastic reports of its efficacy in eliminating air-borne contamination of the operative wound and sterile supplies have appeared in the literature (Hart[8]). However, much more recent studies (Rice and Weed[9]) indicate that, while the bacterial content of the air in the operating room may occasionally be a source of infection for a clean surgical wound, the importance of this source of infection has been greatly overemphasized.

It is my opinion, and I am sure that others share my views, that avoidance of speech and the use of suitable, well fitting face masks are of more importance in the prevention of infection from air-borne bacteria. Indeed it has been said that the hazards presented by a torn glove are greater than those offered by the air (Hirshfeld[3]).

SUMMARY

Prophylaxis is more important than cure in preoperative preparation of the hands. Preparation should start during the surgeon's intern days rather than ten minutes before an operation.

Instruments should be used rather than fingers. The surgeon using his hands the most has the most infections.

Catgut should be used sparingly and should be of as small caliber as is consistent with the strength required.

Operations should be done in as short a time as is consistent with careful and painstaking surgery. Thoughtful surgeons anticipate their next moves. No ordinary operation need exceed one hour.

REFERENCES

1. Meleney, F. L. Infection in clean operative wounds; 9 year study, *Surg., Gynec. & Obst.*, 60: 264, 1935.
2. Devenish, E. A. and Miles, A. A. Control of staphylococcus aureus in operating-threatre. *Lancet*, 1: 1088, 1939.
3. Hirshfeld, J. W. Bacterial contamination of wounds from the air, from the skin of the operator and from the skin of the patient. *Surg., Gynec. & Obst.*, 73: 72, 1941.
4. McCormick, E. J. and Ramsey, T. L. Postoperative peritoneal granulomatous inflammation caused by magnesium silicate. *J. A. M. A.*, 116: 817, 1941.
5. Price, P. B. Bacteriology of normal skin; new quantitative test applied to study of bacterial flora and disinfectant action of mechanical cleansing. *J. Infect. Dis.*, 63: 301, 1938.
6. Ives, H. R., Jr. and Hirshfeld, J. W. Bacterial flora of clean surgical wounds. *Ann. Surg.*, 107: 607, 1938.
7. Robertson, O. H., Bigg, E., Miller, B. F. and Baker, Z. Sterilization of air by certain glycols employed as aerosols. *Science*, 93: 213, 1941.
8. Hart, D. Sterilization of air in operating room by bactericidal radiant energy; results in over eight hundred operations. *Arch. Surg.*, 37: 956, 1938.
9. Rice, T. B. and Weed, L. A. The bacterial content of air in the operating rooms, *Surg., Gynec. & Obst.*, 73: 181, 1941.

Case Reports

PERSISTENT EXTERNAL INTESTINAL FISTULA

REVIEW OF THE LITERATURE WITH REPORT OF AN UNUSUAL CASE FOLLOWING APPENDECTOMY

MAX MICHAEL SIMON, M.D.
Senior Attending Surgeon, St. Francis Hospital
POUGHKEEPSIE, NEW YORK

THE purpose of this paper is to report an unusual case of persistent intestinal fistula following appendectomy and to discuss the cause, prevention and present status of management of this distressing condition. Diseases of and operations on the appendix together constitute the foremost causes of external intestinal fistulas according to Dean Lewis and associates.[1] First place among the unfortunate sequelae of appendectomy is given to intestinal fistula by Royster[2] in his work on appendectomy. Howard A. Kelly[3] quotes five surgeons as having respectively 3.5 per cent, 4 per cent, 18 per cent and 6.6 per cent of intestinal fistulas following appendectomy. Pfiefer and O'Connell[4] reported 1.4 per cent of intestinal fistulas based on over 3,000 cases of appendicitis. From an etiologic standpoint intestinal fistulas have been placed in two general groups. Those which are intentionally established by such operations as colostomy, enterostomy, appendicostomy and cecostomy; and those which are produced by some pathologic process or by trauma, for example, actinomycosis, tuberculosis, malignancy, gun-shot wounds, regional enteritis and penetrating wounds or surgical accidents. The fistulas which result from inflammatory diseases are most frequently the sequelae of appendicitis, diverticulitis, or pelvic inflammatory processes. A similar classification to the above has been suggested by Rigby[5] and Coffey.[6] This paper is concerned only with the persistent type of intestinal fistula which follows appendicitis. In a review of 109 cases of intestinal fistula collected from the records of Johns Hopkins Hospital from 1890 to 1931, Lewis and Penick[1] made the following classification: (1) subsequent to appendicitis (44.9 per cent), (2) associated with other infections (12.8 per cent), (3) attributable to malignancy (2 cases), (4) resulting from trauma and nonoperative measures (5 cases), (5) following operations (19.2 per cent). It has been estimated that approximately 4 per cent of cases of appendicitis are followed by intestinal fistula. Many such fistulas communicate with the cecum. In recent years it has been observed that a considerable number of fistulas follow removal of an inflamed appendix in cases in which terminal ileitis or typhlitis is present. A fistula may follow evacuation of an appendical abscess in cases in which it does not seem feasible to remove the remnant of appendix at the primary operation. A fecalith in the remaining portion of the appendix may be responsible for the formation of such a fistula. Baldwin[7] and Deaver[8] have advanced strong arguments against inversion of the appendical stump. Harris,[9] of San

Francisco, reports a fatality following the pricking of a small vessell in the wall of the cecum while placing the purse-string suture.

Roder,[10] of Omaha, found that of one hundred appendectomies made with the purse-string suture, 88 per cent of the needles and remaining pieces of suture gave positive growths on culture media, proving clearly that the needle had penetrated one or more times the mucous membrane of the cecum. He also called attention to the added danger when the base of the appendix is crushed, since his laboratory investigation had shown that the crushing clamp was found to be frequently contaminated by the infectious material forced to the surface by the crushing process. Furthermore, the ligature which is placed in this crushed groove is not only in an infected field but in devitalized tissue very likely to give way from internal pressure, conditions very different from those described and illustrated by Seelig.[13] Horsley[11] calls attention to the perfect incubation chamber furnished by the purse-string enclosing the depressed stump, as presenting "first, the diminution of the blood supply to the tissues; second, the presence of necrotic material; and third, the formation of a closed sac;" all perfect conditions for abscess formation Babcock[12] concerning the purse-string suture states: "Purse-string, occluding, or enfolding sutures in the caecum, after removal of an infected appendix, are unnecessary and harmful, favoring large sloughs in the head of the caecum." J. F. Baldwin[7] reported 3,215 operations for appendicitis without an intestinal fistula since he abandoned the purse-string inversion of the stump of the appendix. What particularly drew Baldwin's attention to the dangers of a purse-string was the large percentage of intestinal fistulas reported by surgeons who use that method. The chief objections to the purse-string treatment are: (1) It requires much more time; (2) it necessitates more mobilization of the cecum; (3) there is very great danger (88 per cent according to Roeder) of the needle penetrating the bowel with resulting peritonitis; (4) distinct danger of a hematoma from pricking a vessel; (5) danger of necrosis of the encircled wall of the cecum from diminished blood supply; (6) great increase of postoperative adhesions, with resulting postoperative ileus; (7) greatly increased danger of fecal fistulas; (8) the constant menace from burying the necrotic stump in a perfect incubation chamber. The purse-string method is condemned by many surgeons of large experience, many of whom are professors of surgery in medical colleges and by many of national and international reputation so that their opinions are certainly entitled to serious consideration. The simple drop method which was used in Mt. Sinai Hospital in New York when Seelig[13] wrote his article condemning the purse-string is still in use by all of its surgeons and A. A. Berg of that hospital writes as follows: "it has been the method of choice there for the last forty years. I have used it in thousands of cases and have never known a faecal fistula to develop after its use. The procedure is surely the simplest procedure that can be employed. The method is speedy and safe." Robert T. Morris, of New York, published an article detailing his technic in appendectomy which was the same as Seelig's. He stated that he had had no fistulas since he had given up the purse-string suture and had adopted the simple method of Seelig. It has been shown recently by Harry M. Weber and C. Allen Good, Jr.[14] that an invaginated appendiceal stump persists after many years with the inverted stump projecting as a bulbous mass into the lumen of the cecum, resulting in persistent pain and tenderness with the production of polypoid lesions. Charles W. Mayo[15] condemns inversion of the carbolized stump of the appendix and advocates the simple drop stump method. Frank Lahey[16] abandoned the purse-string inversion of the stump about fifteen years ago for the simpler, noninversion method of Seelig. The writer who has employed the simple drop method

in 1,125 appendectomies has had one case of cecal fistula and this followed the removal of a ruptured gangrenous appendix with neglected abscess in which the gangrene had extended to the cecum. This fistula closed spontaneously in four months.

The drain employed at an abdominal operation may be responsible for a postoperative fistula. However, practically every writer on the subject has concluded that the use of drainage material is definitely indicated under such conditions as that of appendical abscess. Hard rubber drains may produce pressure necrosis of a portion of intestinal wall and give rise to a fistula. A fistula is likely to follow any extensive operation in the presence of infection or potential infection. Retained gauze sponges, unabsorbed ligatures, parts of surgical instruments or fecaliths may be the cause of failure of a surgical wound to heal. Incomplete removal of a diseased portion of intestine may be followed by a postoperative fistula or such condition may ensue from disturbance of the blood supply, to bowel wall or other operative trauma. All are agreed, however, that the commonest cause of an intestinal fistula is appendicitis and fistulas have been reported at all levels of the gastrointestinal tract from the duodenum down to the rectum following appendectomy.[8] An intestinal fistula following appendicitis is becoming less common. In fact, it has become very rare with the advent of earlier operation and a more simplified technic. This is extremely fortunate because the cure of these fistulas, especially the persistent variety, presents many serious and difficult problems.

SYMPTOMS

The symptomatology of course is determined by the segment of intestine involved. The closer the opening to the duodenum the more serious the fistula because of the digestion of the abdominal wall and the loss of fluids. Severe toxemia is produced in the high type of intestinal fistula because of the loss of electrolytes, biliary and pancreatic secretions. Walters and Bollman[17] have shown that the same effects follow obstruction high in the intestinal tract, namely, there is an increase in the blood urea and in the carbon dioxide combining power of the plasma, and a decrease in the chlorides of the blood. If the fistula arises high in the intestinal tract as in the duodenum or jejunum, there is usually marked excoriation of the skin as a result of the action of the digestive enzymes. Inasmuch as four quarts of fluid may be lost daily through a high intestinal fistula, dehydration can be extreme. The loss of gastric secretions alone results in alkalosis, while the loss of pancreatic secretions alone will tend to result in acidosis. In many cases, however, the presence of a fistula diverts quantities of both to the surface.

DIAGNOSIS

The diagnosis of external intestinal fistula is usually obvious, although Baldwin[7] expressed the belief that the odor of infection caused by colon bacilli in the wound, and that caused by the fecal material discharged from a fistula may easily be confused by those not familiar with either condition. If the opening in the intestine is very small and the amount of drainage is slight, a history of the passage of gas through this opening helps to establish the diagnosis, or the taking by mouth of dye such as carmine red or methylene blue may reveal whether or not a fistula is present. Purulent material mixed with the fecal discharge indicates infection or abscess about the sinus.

PROGNOSIS

The prognosis depends usually on the site of origin of the fistula, that is, the segment of intestine involved. The prognosis usually improving as one approaches closer to the anus. Colp[18] reported a mortality rate of 51 per cent in cases of duodenal fistula with death occurring as early as three days subsequent to formation of the tract. Fistulas of the upper part of the intestinal tract do not heal spontaneously

as often as those which arise from the more distal segments of bowel. For those requiring operation the prognosis should be guarded. MacLaren[19] found that 19 per cent of seventy-seven patients died following closure of a sinus that appeared after appendectomy. Deaver[8] reported a mortality rate of 49 per cent in 222 such cases in which operation was required. Rankin and Gorder[20] reported twenty-seven deaths in 264 cases in which 379 operations were performed, a mortality rate of 10.2 per cent. The above figures will indicate that the mortality rates reported are extremely variable. The explanation for this is obvious for the factors involved are numerous. In general, it may be said that the general condition of the patient, the type and extent of the fistula, and the skill of the surgeon are the three chief determining factors in mortality rate.

TREATMENT

Prevention of course is the keynote and deserves special emphasis, but sometimes in spite of one's best efforts an intestinal fistula will result. When the fistula appears every effort should be made to help the closure of this fistula spontaneously, that is by medical means. Fistulas which are distinctly more proximal to the anus, that is the so-called "low" fistula, heal spontaneously in from 39 to 88 per cent of the cases.[21] Conservative measures should be tried for from six to twelve months whenever possible before radical methods are employed. The length of time that operation can be deferred will be determined by the level of the fistula, the amount of inconvenience the patient suffers and by his general condition. Conservatism can not be emphasized too strongly. The number of devices and methods of conservative management which have been advocated for the closure of intestinal fistulas are very numerous and it is evident from this that no one method is satisfactory in all cases. Potter[23] employed a Bradford frame on which the patient lay prone. In this method an opening through the frame permits drainage to take place into a bed pan. Erdman[24] treated an intestinal fistula by means of an apparatus for continuous suction which he suspended from a semicircular rod designed by Pool. Ochsner[25] administers egg white orally and this was successful in lessening excoriation. Cameron[26] reported closure of a duodenal fistula in eleven days following continuous use of suction through a catheter placed in the opening of the fistula. Judd[27] and Dixon[28] have also treated duodenal fistulas by this method. Rees[29] obtained a satisfactory result by employment of dressings of commercial dried whole milk. Potter[23] advocated a solution of beef broth and 10th normal hydrochloric acid, with subsequent use of commercial peptone solution (Witte's) to absorb the enzymes. Warshaw and Hoffman[30] introduced hydrochloric acid directly in the sinus and kept the adjacent skin bathed in peptone solution. The injection of bismuth paste still has its proponents. Plugging of the external opening of the sinus tract has been advocated. The plugs have been made of various materials ranging from ordinary gauze packing to tampons of iodoform gauze impregnated with 10 per cent camphorated oil to prevent saturation with secretion and to preclude the concomitant maceration. Chewing gum has been employed as a plug. Of course all such plugs are kept firmly in place by a sponge held *in situ* by adhesive tape or by a tight belt or binder. Plugging of course is contraindicated in the presence of inflammation. Any plan that will prevent dehydration and irritation of the structures adjacent to the fistula is obviously of great help in preparing the patient for operation if this is unavoidable. According to Ochsner,[25] Reyband, in 1827, advocated the insertion of wood or ivory plates into the fistulous opening and Kleybolte, in 1842, described two leather discs connected by a thread which were used for this purpose. Recently Marshall[31] of the Lahey Clinic has reported the use of a button device which appears to be an elaboration of the plan of Reyband. A large flexible

rubber T-tube has been devised especially for use in the treatment of a fistula of the spur type. A thorough attempt at conservative closure is advocated by most authorities before radical methods are employed.

Excoriation of the skin which accompanies intestinal fistula is a factor of greatest concern to the patient, and is perhaps the most urgent condition at the beginning of treatment. That this excoriation is extremely difficult to control is evidenced by the numerous devices and medications advocated for its relief. Constant suction seemingly gives the most nearly universal relief as it removes the offending fluid before it attacks the skin margin. If dressings are applied, the offending fluid is retained in proximity to the skin and maceration is encouraged. A lighted hood helps keep the skin dry and may help to prevent the action of enzymes on the skin and also makes dressings unnecessary. Frequent tub baths have been advocated to relieve the distress of excoriation. Co Tui[32] experimented with kaolin in the care of high intestinal fistulas. Occasionally, an ointment made with kaolin and mineral oil or kaolin and zinc oxide is effective in protecting the skin. The introduction of iodized oil into the fistulous tract has been recommended by Alton Ochsner because of its healing properties and bactericidal activity. Aluminum paint mixed with cold cream until it has a buttery consistency has also been recommended and has been used by the writer. This makes an impervious covering which cannot be washed off. Dixon and Deuterman[21] have used a 10 per cent solution of tannic acid sprayed over the tissues with an ordinary atomizer and claim immediate temporary relief from the distress which accompanies excoriation.

Conservative therapy may fail for numerous reasons, the chief cause being obstruction of the portion of intestine distal to the fistula. Recently we cared for a patient for whom expectant and medical treatment certainly had been given a fair trial over a period of many months and who in addition went through two unsuccessful attempts at surgical closure of the fistula.

CASE REPORT

Case 1. A man, aged forty-one, was referred to me on August 2, 1938 for treatment of a persistent intestinal fistula in the right upper quadrant of the abdomen which had been present for one year. Exploration of abdomen and appendectomy with drainage had been performed elsewhere in May, 1937, for abdominal pain, indigestion, belching of gas and constipation, symptoms which the patient had had for about two or three years. An abscessed appendix was found, removed and drained. He was in the hospital eighteen days and was discharged with a slightly draining wound which healed completely after three weeks at home. He returned to work in July, 1937, but had to cease work after three weeks because of continuous abdominal pain. He re-entered the hospital in August, 1937, when the diagnosis of pelvic abscess was made and operation advised. Following this operation he developed an intestinal fistula which was noted immediately postoperatively. An attempt was made to close the intestinal fistula four weeks later without success. A second attempt was made to close the fistula four weeks later and this, too, was unsuccessful, the fistula appearing again three days postoperatively. He was in the hospital three months at this second admission during which time he had had three operations. He left the hospital with a draining fistula through the midportion of the abdominal incision. The patient was losing weight and strength, was unable to work and the fistula was producing so much digestion and excoriation of the skin that the patient returned to the hospital again in May, 1938, and a rubber T-tube was put in which he wore for two months without much relief of symptoms. He was finally referred to Doctor Anthony Bassler, in New York, with regard to the advisability of making an "effort to block the external opening with a rubber cast large enough to close it" since the rubber T-tube was ineffective. Doctor Bassler considered this procedure inadvisable and recommended removal of the T-tube and surgical closure of the fistula. On July 8, two months after its insertion, the T-tube was removed under general narcosis and a button device was inserted which stayed in about three weeks and then worked out.

Another improved model of button was inserted and that worked out after several days. The fistulous opening in the abdominal wall was growing progressively larger. Undigested food appeared through this enlarged opening twenty minutes to one-half hour after ingestion. The patient was suffering attacks of upper abdominal pain which was followed by increased drainage from the fistula. Constipation had always been a marked feature, the patient going five weeks without a bowel movement on some occasions. All the above described operations and procedures had been performed before this patient came under our care.

Physical examination revealed an emaciated, debilitated, adult male of forty-one, six feet one inch tall who appeared chronically ill, nervous and apprehensive. He walked somewhat bent forward and to the right.

The chest was negative to examination. The rest of the physical check-up revealed nothing except for the presence of a large draining abdominal fistula in the midportion of a scar ten inches in length. The scar commenced just below the ensiform in the midline and ran downward slightly oblique to the right of the umbilicus and extended down for another five inches below the umbilicus to the right lower quadrant. The fistulous opening measured 5½ cm. in diameter and was at about the midportion of the scar about two inches lateral to the umbilicus. The opening was surrounded by a region of granulation tissue and marked excoriation of the skin was present.

Roentgenologic examination after the injection of bismuth paste revealed a large sinus tract communicating with the small intestine. Barium by mouth and serial plates yielded no additional information. Examination after a barium enema had been given revealed that the sinus tract did not communicate with the colon.

The patient was admitted to St. Francis Hospital, in Poughkeepsie, New York, on August 2, 1938. He was given a residue free diet; the gastrointestinal tract was cleansed by means of saline irrigations and mild saline cartharsis. Laboratory studies were done: Blood count: hemoglobin 70 per cent; red blood cells 4,800,000; leukocytes 6,750; polymorphonuclears 55 per cent, lymphocytes 39 per cent, large mononuclears and transitional 1 per cent, eosinophiles 5 per cent. Urine analysis: Amber, cloudy, acid, specific gravity 1.030, albumin—trace, sugar—negative, crystals calcium oxalate, few epithelials.

On August 6, (four days after admission), under general narcosis, the large fistulous opening was packed with iodoform gauze and circumscribed, the surrounding granulation tissue and the midportion of the old operative scar were excised removing an elliptical piece of the abdominal wall with the fistulous opening as its center. The peritoneal cavity was opened. After freeing this segment it was lifted out, bringing with it, attached to its undersurface two coils of small intestine with fistulous openings into either side of the large external fistula. The large external fistula consisted of a dilated proximal and distal loop of small intestine. The two loops of small intestine communicating with the large external stoma were dissected off. The openings in the communicating loops of small intestine (internal fistulas) were closed with two layers of intestinal dulox using a Connell suture for the first layer and a Lembert suture for the second layer. The closure was reinforced with fine interrupted linen. The openings in the small intestine were sutured transversely to the long axis of the bowel in order not to narrow the lumen. The large external fistula, which consisted of a dilated proximal and distal loop of small intestine, was separated, the ends resected so as to create two oblique openings, the longer ends on the mesenteric border. An end-to-end anastomosis was done after the method of Lockhart-Mummery.[22] This anastomosis was also reinforced with interrupted linen sutures. Exploration of the abdomen and the right lower quadrant revealed no remaining appendix. Dense peritoneal adhesions were liberated. A layer closure of the abdominal wall was done with interrupted sutures of chromic No. 2 for peritoneum and fascia, dermal and silk-worm gut for the skin with penrose tube drainage to the fascia. Convalescence was uneventful, temperature and pulse returning to normal and remaining there after the fifth postoperative day. The wound healed by primary union except at the drain site which healed by granulation. The superficial sutures were removed on the eighth postoperative day. The deep sutures were removed on the twelfth postoperative day. The patient was permitted out of bed on the twelfth postoperative day and was discharged on the fifteenth postoperative day (August 21, 1938) with the incision closed and well healed.

Pathological studies of the fistulous tract revealed only chronic inflamation.

The patient has remained well to date. Follow-up examination on May 17, 1941, (two years postoperatively) finds this man the picture of robust health. He is symptom free. The abdominal incision is well healed without a hernia. He has lost no time from work and follows a regular diet. His bowels move every two days but he is not uncomfortable and takes no laxatives. He has regained his normal weight of 178 pounds which is a gain of sixty-three pounds, having weighed 115 pounds during his illness. He was recently passed by two separate companies for considerable sums of life insurance. This case teaches that great lesson of courage.

PREOPERATIVE TREATMENT

Before attempting to close an intestinal fistula the intestinal contents should be evacuated thoroughly by means of irrigation. The patient should be given a non-residue diet for several days prior to surgical intervention and a saline laxative to promote complete emptying of the intestines. Fluids, fruit juices and candy are forced so as to build up a carbohydrate reserve to protect the liver, and to change the bacterial flora of the bowel. The site and character of the fistula must be established and the presence or absence of obstruction in the distal loop must be determined by *x*-ray. This is not always easy and sometimes impossible as was demonstrated in the case reported above. It is essential to detect the chemical or fluid imbalance that so frequently occurs. Loss of chlorides and water must be replaced in every possible way. The patient should be adequately prepared before operation.

SURGICAL TREATMENT

Since the persistent variety of intestinal fistula is obviously due either to disease in the wall of the affected segment of bowel or to distal obstruction, any procedure for relief must provide for the relief of the obstructive factor and for the removal of all diseased tissue. To treat such a fistula merely as an abnormal opening to be closed by some plastic procedure is from this point of view inviting almost positive failure. Surgical intervention should not be undertaken too lightly and only in the cases that do not close spontaneously since operation often requires painstaking disections and calls for the highest degree of surgical judgment and skill. One of the most difficult problems arising in the surgical management of an intestinal fistula has to do with the prevention of peritonitis because the surrounding tissues cannot be satisfactorily sterilized. In the persistent type of small intestinal fistula the abdominal cavity usually has to be opened in order to obtain good exposure. Lockhart-Mummery[22] called attention to the necessity for intraperitoneal exposure to insure maintenance of the blood supply. Simple closure of the fistula consists of inversion of the mucosal edges with two or three layers of chromic catgut and suture of the skin. This procedure is not sufficiently thorough to affect a cure in the persistent case and is not advocated without qualifications by those who have had extensive experience in intestinal surgery.

A more satisfactory procedure is closure by inversion of the mucous membrane and anatomic closure of fascial, muscular and subcutaneous layers. Attention has been called frequently to the importance of maintaining an adequate blood supply in these cases and Lockhart-Mummery[22] and Dixon[28] say that the bowel should be cut at an acute angle with the mesenteric border so that more is taken from the antimesenteric border than from the mesenteric side even if it is necessary to sacrifice normal intestine. This insures a better blood supply. An ample blood supply is imperative for a satisfactory permanent closure. It is also essential to excise the portion of bowel wall which is thickened, indurated and irregular in order to obtain a satisfactory closure; and one must close an opening in the bowel so as to prevent narrowing of the intestine which might result in intestinal obstruction. If it appears that exci-

sion of the bowel wall is so extensive that the opening cannot be safely closed, a resection of the segment must be carried out and the continuity of the bowel must be restored by an end to end or lateral anastomosis. The majority of these fistulous tracts will require considerable operative ingenuity to close and no single method can be employed for all of them. The operative approach must be planned for each individual case and the details of the procedure can be determined only at the time of operation and as the operation progresses. While it is important to visualize beforehand the type of pathology that one may expect to encounter from a detailed analysis of the history, physical examination and *x*-ray study, yet such studies often yield little positive information preoperatively, as is demonstrated in the case reported above.

If considerable manipulation of the viscera has been necessary, an enteric stoma of the Witzel type established proximal to the anastomosis is often a life saving measure. Deaver[8] used one or more enteric stomas according to indications. C. P. Schlicke and C. F. Dixon,[33] of the Mayo Clinic, carry out an enterostomy routinely as a precaution following intestinal resections and the closure of fistulas. Unless there is considerable infection and formation of abscess about the sinus, closure without drainage of the peritoneal cavity is the rule by Claude Dixon.[28] Lockhart-Mummery[22] places a soft rubber drain down to the anastomosis and leaves the drain tube *in situ* for thirty-six hours. The multiple retention sutures of the abdominal wall can be removed on or about the fourteenth postoperative day.

POSTOPERATIVE CARE

Concerning the postoperative care of these patients constant attention to many details is essential. Fluids are restricted by mouth postoperatively and only small amounts of nonresidue liquid are given as tolerated. The fluids are gradually increased by mouth depending on the progress of the case until the fourth postoperative day when a full nonresidue liquid may be permitted, gradually increasing the quantity until the tenth postoperative day when a smooth diet can be provided. The patient should receive about 2,000 cc. of fluid daily which may be given either as a saline hypodermoclysis or 5 per cent glucose in normal saline by the slow intravenous drip method. During the first few postoperative days, when fluids are restricted by mouth, oral hygiene is important to prevent parotitis. Lemon juice and chewing gum are helpful. Fecal inspissation and impaction must be guarded against and can be prevented by the installation of about four ounces of olive oil in the rectum daily. Irritant enemas are dangerous even after the fourth day. Deep breathing, turning in bed and exercise of the arms and legs is a wise procedure. The patient should be permitted out of bed as early as possible consistent with the magnitude of the operation.

SUMMARY AND CONCLUSIONS

1. An unusual case of persistent postappendical high intestinal type of fistula and its management is reported.

2. The etiology, diagnosis, prognosis and management of intestinal fistula is discussed.

3. Diseases of and operations on the vermiform appendix still constitute the commonest cause of intestinal fistulas.

4. Intestinal fistulas are growing less common following appendicitis since the advent of earlier diagnosis and treatment with a more simplified technic.

5. Many intestinal fistulas will close spontaneously and conservative management should be given a fair trial before surgical intervention. The mortality following surgical closure ranges from 8.9 to 50 per cent.

REFERENCES

1. Lewis Dean and Penick, R. M., Jr. Fecal fistulae. *Internat. Clin.*, 1: 111–130, 1933. W. F. Prior Co.

2. Royster, H. A. Appendicitis. P. 346, 1927.
3. Kelly, Howard A. Vermiform Appendix. P. 674. Philadelphia, 1905. W. B. Saunders Co.
4. Pfeifer, J. L. and O'Connell, W. J. *Bull. Am. Col. Surg.*, p. 32, June, 1931.
5. Rigby, H. M. A clinical lecture on intestinal fistula. *Clin. J.*, 38: 289–297, 1911.
6. Coffey, R. C. Remote or indirect subperitoneal drainage in the extraperitoneal closure of persistent fecal fistulae. *Ann. Surg.*, 45: 827–835, 1907.
7. Baldwin, J. F. The prevention of faecal fistula after appendectomy; simple ligation vs. precarious purse-string. *Ann. Surg.*, 95: 704–714, 1932.
8. Deaver, J. B. External fecal fistula following appendicitis. *Ann. Surg.*, 83: 782–789, 1926.
9. Harris, F. L. *Calif. & West. Med.*, vol. 27, No. 1, July, 1927.
10. Roeder, C. A. *Arch. Surg.*, 2: 18–24, 1925.
11. Horsley, J. Shelton. Operative Surgery. 3d ed., pp. 777–778, 1928. W. F. Mosby Co.
12. Babcock, W. W. Text Book of Surgery. P. 1117, 1928.
13. Seelig, Major G. *Ann. Surg.*, pp. 710–720, November, 1904.
14. Weber, Harry M. and Good, C. Allen, Jr. Invaginated Appendiceal Stumps Roetgenologically Simulating Polypoid Neoplasms. Collected Papers of the Mayo Clinic and the Mayo Foundation. Vol. 31, p. 831. Philadelphia, 1939. W. B. Saunders Co.
15. Mayo, Charles W. Appendicitis. Collected Papers of the Mayo Clinic and the Mayo Foundation. Vol. 26, p. 156. Philadelphia, 1923. W. B. Saunders Co.
16. Lahey, Frank. Personal communication.
17. Walters, Waltman and Bollman, J. L. The toxemias of duodenal fistula; physiologic changes concerned in the production of its characteristic chemical reactions of the blood. *J. A. M. A.*, 89: 1847–1853, 1927.
18. Colp, Ralph. External duodenal fistulae. *Ann. Surg.*, 78: 725–744, 1923.
19. MacLaren, Archibald. The closure of fecal fistulae. *Lancet*, 38: 185–189, 1918.
20. Rankin, F. W. and Gorder, A. C. Fecal Fistula, in Rankin, F. W. Bargen, J. A., and Buie, L. A. The Colon, Rectum, and Anus. Pp. 346–358. Philadelphia, 1932. W. B. Saunders Co.
21. Dixon, C. F. and Deuterman, J. L. The management of external intestinal fistulas. *J. A. M. A.*, 2095–2100, 1938.
22. Lockhart-Mummery, J. P. Diseases of the Rectum and Colon. Baltimore, 1934. William Wood & Co.
23. Potter, C. A. Treatment of duodenal and fecal fistula; further observations. *J. A. M. A.*, 92: 359–363, 1929.
24. Erdman, Seward. Laceration of duodenum; rupture of liver, duodenal fistula; jejunostomy feeding; parotiditis; recovery. *Ann. Surg.*, 73: 793–797, 1921.
25. Ochsner, Alton. Intestinal Fistulae, in Nelson's Loose Leaf Surgery, 5: 2951, 296E, 1928.
26. Cameron, A. L. The treatment of duodenal fistula, with report of a case. *Surg., Gynec. & Obst.* 37: 599–606, 1923.
27. Judd, E. S. Personal communication; Dixon and Deuterman: The management of external intestinal fistulas. *J. A. M. A.*, 111: 2095–2100, 1938.
28. Dixon, C. F. The value of sodium chloride in the treatment of duodenal intoxication. *J. A. M. A.*, 82: 1498–1502, 1924.
29. Rees, C. E. Dried milk as a dressing for intestinal fistula: report of case. *Calif. & West. Med.*, 30: 419, 1929.
30. Warshaw, David and Hoffman, W. J. High intestinal fistula: report of case treated by modification of potter method. *J. A. M. A.*, 94: 1050–1052, 1930.
31. Marshall, S. F. The surgical treatment of abdominal fistulas. *New England J. Med.*, 218: 211–220, 1938.
32. CoTui, F. W. The excoriations around external gastro-intestinal fistulae; experimental studies on their etiology and further experience with kaolin powder treatment. *Ann. Surg.*, 98: 242–248, 1938.
33. Schlicke, C. P. and Dixon, C. F. External fecal fistula of eighteen years' duration; report of a case. *Proc.* Staff Meet., *Mayo Clin.*, vol. 15, no. 26, June 26, 1940.
34. Chirurgische Aperationslehre, Herausgeber; A. Bier, H. Braum, H. Krummell: Dritte Vermehrte Auflage; Band 111; Operationen am Bauch. Leipzic Verlag von Johann, 1920. Ambrosius Barth.
35. Monyniham, Sir Berkeley. Abdominal Operations. Vol. 11, pp. 191–192. Philadelphia, 1926. W. B. Saunders Co.
36. McClure, Roy D. *Ann. Surg.*, 94: 203, 1931.
37. Southam, A. H. *Brit. M. J.*, p. 258, February 14, 1931.
38. Macht. *Jobns Hopkins Bull.*, April, 1915; also Clarke and Brown; *J. A. M. A.*, March 17, 1906.
39. Bastianelli. *J. A. M. A.*, p. 2148, December 23, 1922.
40. Bailey, Hamilton. Emergency Surgery. Vol. 1, pp. 40, 44 and 274. 1930.
41. Berg, A. A. Mt. Sinai Hosp., N. Y. Personal communication.

COMPRESSION OF THE SPINAL CORD IN PAGET'S DISEASE OF THE VERTEBRAE

SIDNEY W. GROSS, M.D.
Consulting Neurosurgeon, City Hospital
NEW YORK, NEW YORK

PAGET'S disease of bone or osteitis deformans was first described in 1876 by Sir James Paget[1] in an address to the Royal Medical and Chirurgical Society of London. Paget was sixty-two years old at that time. The description which he gave was so clear-cut and complete and his microscopic study so exact that very little has been added by the numerous students of this disease in the next sixty-five years. Paget did not know the etiology of the condition he described but inferred that the process was inflammatory. At the present time we are not much further along.

Osteitis deformans is a rare disease but not extremely so. It has an average incidence of one case to about 11,000 hospital admissions.[2] Osteitis deformans is a general disease of the skeleton, probably due to some altered constitutional state. The chief manifestations are enlargement and subsequent deformity of the bones. The disease usually begins after the fiftieth year with neuralgic or rheumatic pains in the lower extremities. The tendency for the disease is toward a slow gradual involvement of the entire skeleton, though it may be confined to a single bone or part of a bone for many years. The bones involved in their order of frequency are: skull, tibia, femur, pelvic bones, spine, clavicle, ribs and radius.

Paget's disease is of neurologic interest because the skull and spine are so frequently implicated. Progressive loss of vision and hearing result when the optic and auditory nerves are compressed by the thickened bone in the base of the skull. The cochlea and semicircular canals which are encased in bone may be affected also.[3] Cerebral symptoms have been reported, and these presumably are due to a reduction in cranial capacity by encroachment of the proliferating calvarium.

FIG. 1. Anteroposterior *x*-ray showing increased density of the bodies of the fifth and sixth dorsal vertebrae.

Although the vertebrae are often involved, compression of the spinal cord by the thickened bone is most uncommon. In 1939, Schwarz and Reback[4] in a review of the literature found only ten cases of Paget's disease of the vertebrae with spinal cord compression. They added nine cases from the extensive material at the Neurological Institute. Only three of their nine patients were operated upon.

CASE REPORT

Our patient was a fifty-three year old retired patrolman. His illness began in June, 1939, with cramp-like pains in the left knee. In August, 1939, pain in the lower extremities became more severe and he was forced to use crutches in walking. He was treated for "arthritis." By June, 1940, his lower extremities were so weak that he was bed- or chair-ridden. He continued to lose strength in the lower extremities until they were practically powerless and numb. At this time he developed incontinence of urine and feces. Examination on December 29, 1940, at the Beth David Hospital (service of Dr. L. Hauswirth) was as follows:

The patient was well developed and well nourished. Except for the neurological changes there were no abnormal findings.

He had a spastic paraplegia in extension. Voluntary movement of the lower extremities was entirely absent. The deep reflexes were markedly increased and Babinski's sign was bilaterally positive. There was a sensory level for all forms of sensation at the sixth dorsal skin segment. Beevor's sign was positive. The fourth, fifth and sixth dorsal spinous processes were tender on pressure. A spinal puncture yielded a slightly xanthochromic fluid of high protein content. There was a complete manometric block. *X*-ray examination of the skull, spine and extremities showed changes in the left ilium and the bodies of the fifth and sixth

FIG. 2.

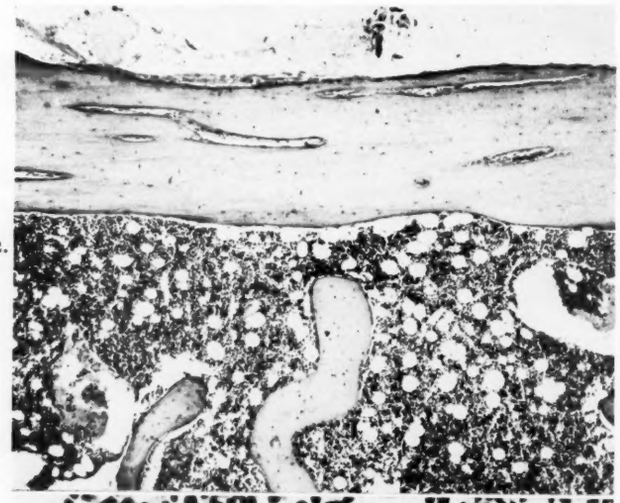


FIG. 3.

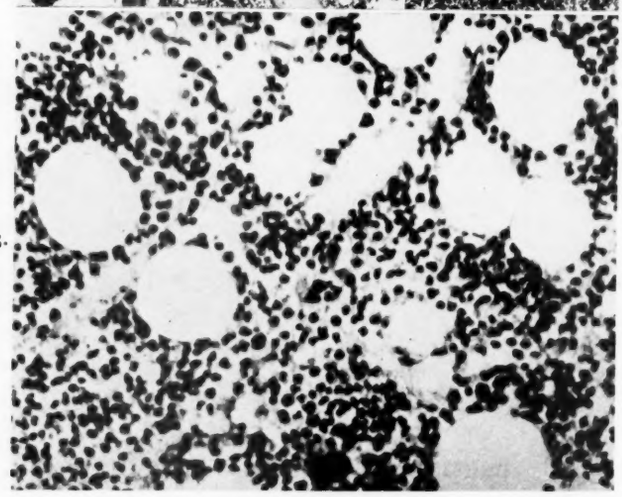


FIG. 2. Photomicrograph of section of bone removed from the lamina. × 50.

FIG. 3. Note the vascular sinuses surrounded by small round cells. × 350.

dorsal vertebrae. (Fig. 1.) The body of the fifth dorsal vertebra showed marked condensation of bone while in the ilium areas of rarefaction and condensation were present side by side. These changes are so typical that they may be considered pathognomic of Paget's disease.

A laminectomy was done under general anesthesia. The spines and laminae of the fifth and sixth dorsal vertebrae were removed. The bone was markedly thickened, vascular and peculiarly brittle. The dura, arachnoid and spinal cord appeared normal. The patient had a smooth convalescence. He gradually regained the use of his lower extremities; bladder and bowel function improved; and at the time of discharge he was able to walk with assistance. The sensory changes were markedly improved.

Microscopic examination of the bone removed showed two parallel layers of compact bone in which Haversian canals are seen cut longitudinally. Between the compact bone dense trabeculae are seen surrounded by a very cellular vacuolated tissue. (Fig. 2.) This tissue is made up of small round cells with darkly staining nuclei. These cells resemble lymphocytes. Many large multinucleated cells are seen. On close inspection the large vacuoles are found to have a fine endothelial lining and they are evidently vascular sinuses. (Fig. 3.) At the last examination in June, 1941, the patient walked without a cane. The reflexes were slightly hyperactive. Babinski's sign was absent and there were no sensory changes. Bladder and bowel function were normal.

Schwarz and Reback[4] have recently discussed the pathogenesis of spinal cord compression in Paget's disease and the technical difficulties encountered in performing a laminectomy in the presence of Paget's disease of the vertebrae. The bone may be so thick that the rongeurs in common use may not open wide enough. In our case the bone was very vascular and peculiarly brittle.

This case illustrates once again that even though loss of power may be complete and of several months' duration, in the presence of spasticity and hyperactive tendon reflexes, recovery may be expected when compression of the spinal cord is relieved.

REFERENCES

1. Paget, James. On a form of chronic inflammation of bones (osteitis deformans). *Tr. Med. Chir. Soc.*, 60: 37–64, 1877.
2. Moore, Sherwood. Observations on osteitis deformans. *Am. J. Roentgenol.*, 10: 507–518, 1923.
3. Moore, Sherwood. Osteitis deformans and the eye, ear, nose and throat specialties. *Ann. Otol., Rhinol. & Laryngol.*, 36: 662–665, 1927.
4. Schwarz, G. A. and Reback, S. Compression of the spinal cord in osteitis deformans (Paget's disease) of the vertebrae. *Am. J. Roentgenol.*, 42: 345–366, 1939.

PNEUMOCOCCIC PERITONITIS

MAURICE CULMER O'SHEA, M.D.
Assistant Surgeon and Chief of the Surgical Clinic, St. Vincent's Hospital;
Associate Surgeon and Chief of Surgical Clinic, Harlem Hospital
NEW YORK, NEW YORK

PNEUMOCOCCIC peritonitis, which always has been relatively uncommon, has become extremely rare in the past decade due to the ever improving standards of living and the treatment of pneumonia by chemotherapy. At St. Vincent's Hospital there have been only three cases of this condition among the 70,100 admissions during the last seven years. Of these three cases one was in a child who had pneumonia, and two were in women in the fourth decade of life with the initial pathological conditions in their fallopian tubes. Therefore, of the 2,280 patients with pneumococcic pneumonia treated at St. Vincent's Hospital during these seven years, only one case of pneumococcic peritonitis resulted as a complication of the pneumonia and that case was in a child. This is amazing when one considers the number of patients with pneumonia who have a bacteriemia.

Pneumococcic peritonitis may be caused by a blood stream infection originating in the lungs or throat, but is more commonly the result of an extension of an infection of the fallopian tubes. The condition occurs most frequently in young girls under ten years of age in families of low economic strata. A positive diagnosis can be made only when the organism is found at operation or by an abdominal puncture. This latter procedure should be performed very early in the disease for fear of perforating the intestines which soon become matted together with fibrinous adhesions. At first the pus is odorless, thin, flaky and albuminous, but quickly becomes thick, creamy and fibrinous, and glues the intestinal loops together. It has a tendency to form into pelvic abscesses which often grow to large dimensions and necessitate surgical intervention with drainage, and not infrequently the removal of the tubes and ovaries which tend to act as a constant source of infection. The blood cultures are usually only positive in very severe infections in which pneumonia, pleurisy, pericarditis or other conditions are present. If an absolute diagnosis can be made and if no abscess is present, surgery is not indicated but chemotherapy should be commenced immediately. If fluid from the intraperitoneal puncture on a smear shows Gram-positive diplococci, the diagnosis of a streptococcic or pneumococcic peritonitis is fairly certain. If facilities are available for rapid typing of the pus, early intraperitoneal injection of pneumococcic antiserum is indicated, according to Scaravelli.[9] However, although not practiced in any of the three cases here reported, it seems that if a diagnosis can be made by intraperitoneal puncture, the injection of sodium sulfapyradine in ample dosage should be carried out immediately after the diagnosis is made. This medication should be augmented by the administration of the azodye by mouth or vein.

The pain is usually severe in its intensity and has colicky exacerbations. The temperature rapidly rises to 104°F. or over, and the white blood count ranges from 30,000 to 40,000 cells with the polymorphonuclear count proportionately very high. There are frequently loose stools of an irritating character and cyanosis is not uncommon among children.

Pneumococcic peritonitis has been recognized as a disease entity since 1865 when Bozzola of Turin, Italy, first described a case. Since then the condition although not rare, has become increasingly uncommon. Schonenberger,[9] in a review of all the cases reported in the literature prior to 1929, found 158 cases of "localized" pneumo-

coccic peritonitis with a mortality rate of 49 per cent, and 218 cases of "diffuse" pneumococcic peritonitis with a mortality rate of 86 per cent. Bass,[3] in an excellent review of 376 cases in the literature (both localized and diffuse), reports a mortality rate of 58 per cent, and he further reports nineteen cases in twelve years on an active pediatrics service of one hundred beds. Obadalek[7] reported fifty cases in ten years in Brunn, Germany. Rolleston[3] collected only eleven cases in a series of 4,454 cases of pneumonia. Sir Barrington-Ward,[2] in 1939, reported the condition becoming increasingly rare on the pediatric service of the Hospital for Sick Children, London, during the previous ten years. Doran and Allen[4] likewise report an ever diminishing incidence of the condition on the Children's Surgical Service at Bellevue Hospital, New York.

The following are the case histories of the three patients above mentioned. Two patients recovered and one patient, who originally had a type III pelvic infection and subsequently developed a type VIII lobar pneumonia and empyema, died. Of the two patients who survived, one had a type I pneumococcic pneumonia and peritonitis, and the other had a type XXVIII pneumococcic peritonitis as a result of a pneumococcic salpingitis. Thus it appears that no one particular "type" of the organism has a predilection to spread to the peritoneum.

CASE REPORTS

Case I. J. R., a twelve year old Porto Rican girl was treated from July 7, 1933, to October 15, 1933, for intestinal parasitic infections. She was readmitted to the hospital on October 24, nine days after being discharged, with a type I pneumococcic lobar pneumonia. She was treated with type I pneumococcic serum. On November 6, 1933, a large inflamed and indurated area appeared on her abdominal wall just above the umbilicus. This area persisted for several weeks and then became necrotic and sloughed its fascial layers. It subsequently healed leaving a large ventral hernia. On November 17, an abdominal puncture was performed, and 1,500 cc. of a thick, viscid, greenish-yellow and odorless pus was withdrawn without any difficulty. This pus showed type I pneumococcus. She was given blood transfusions on several occasions. Her stools still contained ova of the Schistosoma mansoni (26 in 5 slides), and occasional ova of the Trichuris trichura and hookworm, and one cyst of the Entamœba coli. On November 29, 1933, she had a thoracotomy for an empyema on the right side, and on December 14, 1933, a thoracotomy for empyema on the left side.

The sputum, blood, abdominal pus and the pus from both empyema cavities were positive for type I pneumoncoccus.

The child made a slow recovery and was discharged on March 7, 1934, with a ventral hernia. The repair of the hernia was postponed until a later date because of her long protracted and complicated illness.

Case II. Mrs. M. S., age forty-two, grava II, para II. was admitted to the Gynecological Division on June 4, 1939, with a diagnosis of a possible ruptured ectopic pregnancy or a twisted ovarian cyst. There was no history of any vaginal discharge. Her last menstrual period, which was more profuse and lasted longer than usual, ended three days previously, but on the following day she again commenced to bleed and was still spotting at time of admission. She was awakened at 2 A.M. (eight hours before admission) by severe pain in the lower portion of the abdomen. This pain was relieved by drawing up her thighs and legs. She vomited twice and had two loose stools before admission.

Abdominal examination revealed marked rigidity of the entire abdomen with tenderness and rebound tenderness in both lower quadrants. Vaginal examination disclosed no evidence of any discharge, but there was exquisite tenderness in the right lower quadrant when her cervix was moved. Examination of her throat, heart and lungs was negative.

She was operated upon a few hours after admission for the above named diagnosis, but when the abdomen was opened a large quantity of creamy pus was found free in the abdominal cavity and a large pelvic abscess was present. This abscess in the posterior cul-de-sac was drained and the abdominal fluid was cultured and smears made. Type III pneumococcus was found and the patient was given large doses of sulfapyridine immediately postoperatively. She developed a draining sinus from the lower angle of the wound and was discharged to the out-patient department with it still draining

on July 22, 1939. On September 23, 1939, she was readmitted to the hospital because of an abscess of the abdominal wall which had formed near the draining sinus. An operation under local anesthesia evacuating the abscess and exposing the sinus tracts was performed. The sinus tracts were packed with iodoform and the patient treated with heat under a cradle. She was discharged from the hospital on November 18, 1939, on her fifty-ninth day with all wounds healed.

On March 4, 1940, (three and one-half months later) she was readmitted with bilateral tubo-ovarian abscesses and an external draining sinus in the right lower quadrant. She was operated upon ten days later, when upon opening the abdomen all the intestines and the pelvic structures were found adherent. The adnexa on each side formed two large abscesses, each the size of a grapefruit. The sinus tract was dissected out and a bilateral salpingo-oophorectomy was performed and a drain placed in the posterior cul-de-sac. Postoperatively the patient developed a fecal fistula. She was given a blood transfusion on March 28, 1940. Thereafter she developed pain in both low thoracic regions with signs of bilateral hypostatic pneumonia. She was again given sulfapyridine therapy. On April 26, 1940, she was operated upon for empyema. The culture from the abdominal pus was type III. Her condition failed to improve following the thoracotomy, and she died on May 2, 1940, eleven months after her first admission.

Case III. *Diffuse Pneumococcic Peritonitis.* Mrs. M. D., age forty-one, a widow, grava III, para I, was first seen by me on February 8, 1940, when she came to my office complaining of marked pain about her vagina and of being "unusually nervous." Her past history revealed that she had had two miscarriages (five months and two months) and subsequently had a full term pregnancy, the child now being nine years old. At this delivery she had a severe tear and a deep episiotomy which required considerable repair. She had had menorrhagia, metrorrhagia and dysmenorrhea for several years and recently this condition had become worse. She also gave a history of exposure two weeks prior to onset of pain.

Three weeks before, she developed pain about her vagina, which was accentuated by a sitting posture, and for two weeks, she had had profuse vaginal discharge. Her menses usually were of fourteen days' duration but her last period was only nine days in duration, beginning January 23, 1940. She had felt unusually tired and nervous and had been quite depressed, suffering occasionally from dizzy spells and suboccipital headaches.

Physical examination revealed a middle-aged, white woman with face flushed, motions nervous, weight 126 pounds, temperature 99°F. and blood pressure 150/80. Her throat was inflamed and there was a slight postnasal drip; the pulse was 72, and the lungs and heart were normal. Vaginal examination disclosed that the uterus was normal in size, shape and position. There was no tenderness or fullness in the right or left fornix, but there was a thick discharge with some necrotic tissue in the posterior fornix, with an area of slight erosion about a scar in the cervix. The urinalysis showed 100 white blood cells per high powered field with fifteen to twenty clumps of pus cells, an occasional red blood cell and a trace of albumen. A cervical smear revealed a large number of pus cells and epithelial cells and a small number of staphylococcic, micrococci-catharrhalis and smegma bacilli. A mild cleansing douche and a urinary antiseptic were prescribed and the cervical erosion cauterized.

Ten days later the patient appeared at my office and stated that she felt considerably improved, but that she still had some pain about her vagina, which, as previously, was worse when she was seated. Examination showed some improvement in her condition.

One week after this visit and two-and-a-half weeks after the first visit, she was suddenly seized in the middle of the night with severe generalized abdominal pains of a colicky nature. These pains continued for several hours and were accompanied by nausea, vomiting, fever and the passage of three or four fairly loose stools that seemed as though they were "boiling hot." She had no chills nor any dysuria. Her general appearance was that of a person in severe pain. The rectal temperature was 103.4°F. The abdomen was tender, rigid, distended and tympanitic in all four quadrants. She was still menstruating from a period which had begun five days previously and which was accompanied by pains that were unusually severe and cramp-like in character. She gave a history of having eaten some oysters of doubtful color and quality two days previously, and for dinner the night before had partaken of fresh ham. With this history and the sudden onset of such generalized and severe symptoms,

it appeared that she was suffering from an acute gastroenteritis. A hyperdermic of morphine and atropine, and an ice bag to the abdomen were prescribed, and she was observed again four hours later. At this time her symptoms and physical signs seemed more advanced and she was advised to seek further treatment in the hospital.

On admission to the hospital her temperature was 102°F. and her white blood count was 33,000 with 91 per cent polymorphonuclears. Her throat was slightly inflamed, the lungs were clear and the heart normal. Her abdomen was generally tender, rigid and distended. Her pain was now located mostly across the middle of her abdomen. She had the desire to defecate and pass flatus, but had been unable to do so for the past twelve hours. Rectal examination and vaginal examination disclosed bilateral tenderness. Shortly thereafter the pain became less intense, but its colicky nature and her nausea and vomiting persisted. She was quite dehydrated and continuous intravenous fluids were given. Prontosil and neo-prontosil medication were commenced and a Wangensteen tube passed. By this time it seemed that instead of a gastroenteritis, she had a diffuse peritonitis that originated from a spread of a possible pelvic inflammatory disease. The *x*-rays taken on the night of her admission to the hospital were not very enlightening as to her intra-abdominal condition and were reported as follows:

February 25, 1940: Examination of the abdomen in the prone, supine and erect postures showed a fairly even distribution of gas throughout the colon. The sigmoid appeared to be redundant. No evidence of fluid levels was demonstrated, and there was therefore none of the usual roentgenographic signs of a complete mechanical ileus. No evidence of gas or air was demonstrated in the subphrenic spaces.

On the day after admission her white blood count still showed 30,000 cells with 90 per cent polymorphonuclears, and the sedimentation time was rapid (24 mm. in twenty minutes). A smear from the cervical os was again negative for gonococci and her temperature ranged about 101°F. The Wangensteen tube was draining off huge quantities of putrid smelling, greenish-brown intestinal contents, that at times became red in color from the prontosil medication which now was being given only intramuscularly. New *x*-ray plates suggestive of small gut obstruction were taken and reported as follows:

February 26, 1940: Examination of the abdomen in the prone and erect postures showed numerous loops of gas distended small bowel, several of which showed fluid levels when the patient was examined in the upright posture. These signs are suggestive of an obstructing lesion.

These *x*-rays indicating the probable existence of an intestinal obstruction raised the question as to whether it was a mechanical obstruction or a paralytic ileus from a generalized peritonitis of pelvic inflammatory origin. An operation scheduled for this day (i.e., day after admission) was postponed because her condition seemed to improve slightly and because it did not appear that she had a mechanical obstruction. The following morning, however, her distention had increased and was localized mostly in the right upper quadrant and it was feared that she might possibly have a mechanical obstruction in her small intestines. A laparotomy now seemed to be indicated. Consequently, under cyclopropane-oxygen anesthesia a laparotomy was performed forty-eight hours after the onset of the acute attack.

The abdomen was opened by a right rectus incision. There was relatively no free fluid in the abdominal cavity, but all the visible organs were covered with a thick, odorless, creamy, seropurulent exudate. All the loops of the small intestines were plastered together with a fibrinous exudate and adhesions, which had formed remarkably early for the type of infection present. There were no dilated loops of gut and the intestinal surfaces were shiny and lacked the customary redness present in peritonitis. The pelvic organs were visualized with difficulty; the uterus had a small subserous fibroid on its posterior surface and the left tube was slightly enlarged and adherent to the uterus. There seemed to be no greater peritoneal reaction or amount of exudate in the lower abdomen than in the upper abdomen. The gall-bladder and stomach appeared normal. Smears and cultures were made from the exudate.The obstruction, in the absence of any distended loops of intestines, was believed to be due to a paralytic ileus. The abdomen was closed without drainage by four through-and-through sutures and by the tier method with interrupted chromic catgut sutures.

The abdominal smear showed Gram-positive diplococci and the culture and typing were positive for type XXVIII pneumococcus. The prontosil medication was stopped shortly after operation and 5 Gm. of sodium sulfapyridine were given and later supplemented with sulfa-

pyridine by mouth. Two days later the white blood count had fallen from 30,000 to 9,400 and the polymorphonuclears showed a shift to the left of 24 per cent. Monocytes were present in 8 per cent as well as megaloblasts and many nucleated red blood cells. At no time did the Marshall test show a concentration higher than 7 per cent. Because of the abnormal and young forms of cells present in the blood, this medication was discontinued temporarily on March 2nd, four days after operation. Three days later it was again given for a period of forty-eight hours, in the hope of keeping the exudate thin and preventing the common complication of a secondary pocketing and abscess formation. The patient received two transfusions of 500 cc. each of citrated blood and was kept on continuous intravenous fluids for several days. The Wangensteen tube drained freely the first four postoperative days and was then removed without any discomfort to the patient. The abdominal distention continued for over two weeks but gradually subsided. On the seventh postoperative day the patient had a tremendous watery stool and from then on evacuated normally. The wound healed cleanly and apparently firmly and the patient was allowed out of bed on her sixteenth postoperative day and discharged from the hospital on her twenty-first day with a normal blood count. Following her return to her home her convalescence remained uneventful, and a follow-up sixteen months later revealed her to be symptom-free and in good health.

The operation in this case, established the diagnosis and permitted the use of the proper medication with adequate dosage of sulfapyridine. The administration of the sulfonamides are believed to be accountable for the avoidance of the not uncommon complication of a secondary pelvic abscess as well as her complete and uneventful recovery.

SUMMARY

Three cases of diffuse pneumococcic peritonitis occurred among the last 70,100 admissions to St. Vincent's Hospital. Of 2,280 cases of pneumococcic pneumonia only one patient developed a pneumococcic peritonitis. This patient was treated with type I antipneumococcic serum. Her illness occurred prior to the use of chemotherapy in the treatment of pneumonia.

Absolute diagnosis can be made only by culture of the abdominal pus obtained either by laparotomy or abdominal puncture. The latter procedure should only be performed early in the disease before intestinal adhesions occur as a result of the fibrinous exudate.

Chemotherapy with the proper sulfonamide is indicated as soon as the diagnosis is made. Serum of the proper type should be given as well as the azo dyes, in cases which do not respond quickly.

Surgery is contraindicated unless an intra-abdominal abscess occurs. Before closing the abdomen about 12 Gm. of sulfapyridine should be scattered over the involved area.

The intraperitoneal injection of sulfapyridine or antiserum or both, although not used in any of the cases here reported, appears to be of value and worthy of consideration in the future.

For the past ten years the condition has become less common among young girls. Two of the three cases herein reported were in married women in their fourth decade, and one in a girl of twelve years of age.

The mortality of cases reported in the literature prior to the use of the sulfonamides varied between 58 and 86 per cent.

The mortality in these three cases of diffuse pneumococcic peritonitis was 33⅓ per cent. The one death occurred after the patient developed pneumonia of a different type and subsequently was operated upon for empyema.

REFERENCES

1. Barrington-Ward, Sir Lancelot. Brit. M. J., 2: 704–706, 1932.
2. Barrington-Ward, Sir Lancelot. *Practitioner*, 142: 367–374, 1939.
3. Bass, Murray H. *Med. Clin. North America*, 19: 847–855, 1935.
4. Doran, Wm. T. and Allen, Phillip. Personal communication, 1941.
5. Horine, C. F. *Ann. Surg.*, 102: 391–394, 1935.
6. King, J. E. Pneumococcic pelvic infections in adults. *J. Obst. & Gynec.*, 29: 341–349, 1935.
7. Obadelek, W. *Deutsche Ztschr. f. Chir.*, 233: 581, 1931.
8. Scaravelli, C. Six cases with advantage of early intervention and injection of anti-pneumococcus antiserum. *Policlinico*, 42: 979–986, 1935.
9. Schonenberger, Emil. Basil Thesis, 1929.

CRANIAL CHORDOMA*

REPORT OF A CASE IN WHICH SURGICAL INTERVENTION WAS SUCCESSFUL

F. A. CARMICHAEL, JR., M.D.,
Attending Neurosurgeon, Kansas City General Hospital

F. C. HELWIG, M.D.
Chief of Service on Pathology Staff, Kansas City General Hospital

AND

J. H. WHEELER, M.D.
Instructor in Internal Medicine, University of Kansas

KANSAS CITY, MISSOURI

ONLY lately have reports begun to appear concerning successful palliative surgical attack on cranial chordoma. Gardner and Turner[1] in a recent excellent article have summarized our present knowledge of the subject and reported three cases of their own.

Because we have seen three cases† within the past six months, in one of which the patient was operated upon with at least temporary recession of symptoms, it would appear that the disease is not as rare as had been previously considered; and we hope that the recording of an additional case in which the patient was benefited by surgery may serve to re-emphasize a condition which has usually been considered more or less refractory to surgical attack.

CASE REPORT

Mrs. H., a rather pleasant, somewhat obese, mentally alert, female of forty-seven was first seen by one of us (J. H. W.) on August 4, 1939, at which time she complained of earache, deafness, tiredness and loss of twenty-five pounds in weight. At this time the most persistent complaint was deafness of the left ear which she believed was due to something obstructing the left ear canal.

On examination the patient showed some edema of both posterior faucial pillars and moderate redness of the throat, for which she was referred to an otorhinolaryngologist. He treated her eustachian tubes locally for several days with apparently excellent results. A basal metabolic rate done at this time was minus twenty-six. The urinalysis showed a slight trace of albumin. Estimation of hemoglobin by the Haden method was 76 per cent. The red cells were 4,120,000 and the blood sugar was 91 mg. per cent. Because of these findings the patient received Burroughs-Wellcome thyroid extract, gr. 5 daily for approximately one hundred days.

She was next seen on December 17, 1940, at which time she was admitted to St. Luke's Hospital with a complaint of marked photophobia of the right eye. The left eye was totally blind, having been so at least several months prior to August 1939. Her teeth had been *x*-rayed and had been found not to be faulty. The patient stated at this time that she had been having severe headaches which sometimes awakened her at night and almost always were present on awakening in the morning, and that these had become so severe that she was forced to enter the hospital.

Neurologic examination at this time disclosed the following findings:

Ophthalmoscopic examination revealed that the right optic nerve head was extremely pale, graded plus two on a basis of one to four. The left optic disc was completely atrophic. Examination of the visual fields revealed an upper temporal quadrantic defect in the right eye and complete blindness in the left. The left eyelid drooped somewhat, and there was a manifest external strabismus due to paresis of the left third and sixth cranial nerves. Ocular movements of the right eye were normal. The left eye was essentially immobile in all planes. The pupils were large and equal, both round, and the right reacted to light and accommodation while the left was unreactive. The left

† Two of these cases with necropsy studies will be reported later in another communication by Dr. Victor Buhler and associates from the Kansas City General Hospital.

* From the Departments of Neurosurgery and Pathology, St. Luke's Hospital, Kansas City, Missouri.

eye was noted to be somewhat more prominent than the right in spite of the presence of ptosis of the left lid. The sensation in the right half

Fig. 1. Left lateral view showing dispersed areas of suprasellar calcification extending into the left middle fossa and destroying the posterior clinoid processes, dorsum sellae, clivus and left sphenoid wing.

of the face was normal, but on the left there was a subjective diminution in the appreciation of touch and pin prick over the distribution of the fifth cranial nerve. There was no dysfunction of the seventh cranial nerve, and the hearing was depressed in the left ear. The palate was freely movable and there was no dysfunction of swallowing or breathing. The sternomastoid and trapezius muscles functioned well bilaterally.

In appraisal of the reflexes, it was noted that there was a subjective diminution of the corneal sensation of the left eye. The reflexes in the upper extremity were normal and symmetrical, and pyramidal tract signs were absent. Likewise, examination of the reflexes of the lower extremity and abdomen yielded physiological results.

In view of these findings, it was assumed that the patient was suffering from a retrobulbar or retro-orbital mass lesion and consequently *x*-rays of the cranium included the orbital fissures and optic canals. *X*-rays disclosed the presence of a large, irregularly calcified lesion in the left middle fossa which had caused almost complete destruction of the sella turcica, posterior clinoid processes and had eroded and enlarged the left orbital fissure and left sphenoid wing. (Fig. 1.)

The past history of this patient is of considerable interest inasmuch as it conforms very well to the pattern of many cases previously reported in the literature. In 1934, the patient began gradually to have a rather creepy sensation running up the left side of her face. This was said to have occurred about every day or every other day and would last only a few seconds. At this time she had three or four terrible headaches which awakened her at night. The patient was unable to give any intervening history between 1934 and July, 1937, at which time she consulted an oculist because of some visual disturbance and photophobia, principally in the left eye. At that time she had a medical examination which disclosed nothing. Again in the fall of 1937 the patient consulted her oculist who gave her ocular exercises. At that time one of the doctors remarked that the left third nerve was paralyzed. However, she had not at that time noted diplopia. After three months of ocular exercises, she continued to have visual difficulty in her left eye. It was then recommended that she have an extraction of a tooth which resulted in a cessation of the parasthetic symptoms over the left side of her face for about a year.

In 1938, however, the parasthesia of the face returned and again a tooth was extracted with cessation of symptoms. She remembers distinctly that she could see somewhat with the left eye at this time. The teeth and sinuses were again *x*-rayed and on a basis of these *x*-rays a tonsillectomy was advised. This, however, was not carried out. In the fall of 1938 she consulted an ophthalmologist who gave her a prescription containing potassium iodide. This made the patient quite sick and she discontinued its use immediately.

In 1939, the patient was definitely blind in the left eye. The development of blindness had been so gradual that she did not know definitely when she lost her vision, but she is quite firm in believing that after blindness developed, she could see much better with the right eye.

During the early part of 1940, she had left frontoparietal headache often, but this was not an excruciating type, although occasionally severe enough to awaken her during the night. If she got up and walked about the house, the headache would stop. There was no associated nausea or vomiting.

In the early part of December, 1940, the headaches had become so severe that the patient was considerably discomforted by them and awakened at night almost continually. It was because of this symptom of headache that the patient finally was admitted to the hospital.

Operation. On January 8, 1941, under intertrachial ether anesthesia, a large osteoplastic flap was reflected in the left temporal region, exposing the dura, which was incised and reflected, revealing the cortex of the left temporal lobe with the convolutions greatly broadened and flattened. To the palpating finger the cortex was quite firm, and exploring the cortex with the cannula the surgeon found that resistance was encountered at the depth of 1 cm. The middle temporal convolution was then incised, exposing a tough, slick, firm, whitish membrane beneath the cortex about the depth of 1 cm. Upon incision of this tough membrane, the tumor tissue oozed out spontaneously, the tissue being composed of a gelatinous like substance, of a somewhat dirty, whitish gray to red color.

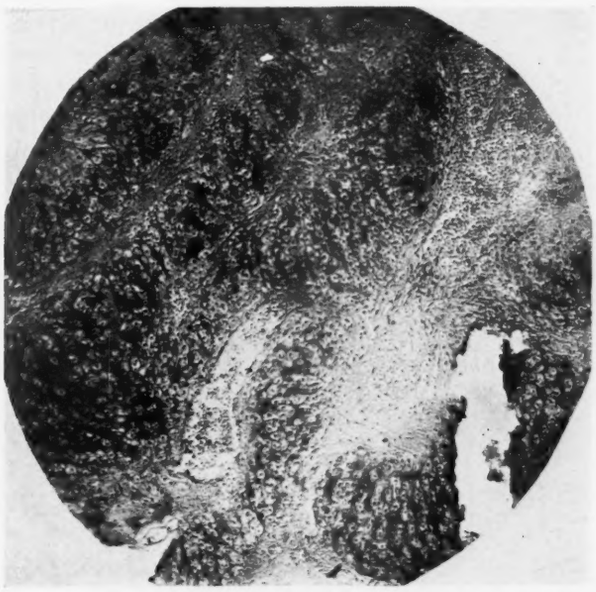


Fig. 2. Low power photomicrograph showing a typical area in the tumor. Note the matrix, tumor cells and fragile blood vessels.

The incision through the capsule was thereupon enlarged, and the tissue mass removed chiefly by suction. After a considerable amount of the neoplastic tissue was so removed, large islands of more condensed and calcified tissue were removed by the use of pituitary forceps. After removal of all the neoplastic tissue, the middle fossa was bared, the left optic nerve and carotid artery were exposed, the back of the orbit and sphenoid wing being absent, allowed ready access to the left orbit from which large quantities of tumor tissue were removed. The left optic nerve was one-half its normal size. The tumor could be seen extending posteriorly across the petrous ridge. All the tumor tissue which could be seen was removed, and after hemorrhage was controlled, the wound was closed in the usual manner.

Postoperative convalescence was essentially uneventful. Surprisingly enough, the patient showed only a mild degree of disturbance of speech. She was dismissed from the hospital about twelve days following her operation. Up to the present time the patient has suffered only the inconvenience of moderate mal occlusion of the teeth because of affectation of the left pterygoid muscles. The patient is bright and alert and subsequent examination of the perimetric field has shown that the vision of the right eye is greatly improved.

The patient was last examined January 5, 1942, approximately one year after her operation. At this time she seemed quite bright, alert and able to carry on the usual duties of a housewife. Her visual field defect of the right eye had expanded considerably, the visual acuity being 20/20 in the right eye. The patient on this date showed no neurologic evidence of recurrence, and the small decompressed area in the left temporal bone was flaccid and pulsating.

Gross Pathology. The material removed at operation was a reddish, mucinous, soft sticky mass from which impression smears could be obtained readily. It resembled nothing so much as the mucin of a soft mucoid carcinoma. In addition there were many varying sized fragments of bone and calcific material.

Histologic Pathology. Impression smears were made at the operating table and stained with toluidine blue. These preparations revealed at once the true character of the neoplasm.

With paraffin sections stained with hematoxylin and eosin, a stringy, deeply blue staining, mucinous matrix was observed which enmeshed long columns and nests of oval and rounded sharply defined tumor cells with a sharply defined basophilic cytoplasmic border. The cytoplasm of these cells was faintly pink or orange staining and often granular in character. The nuclei were small, round or oval and stained basophilic. (Fig. 2.) In some areas the cells somewhat suggested young embryonal cartilage cells.

The vascular supply of the tumor was quite abundant. The vessel walls were usually poorly preserved. The very delicate, mushy, gross character of the growth may have been responsible for the fact that the walls of the majority of the vessels were fractured. Often masses of orange to pink staining tumor cells and mucinous blue matrix were seen penetrating the lumena of the vascular channels. Aside from the bluish matrix very little to suggest any type of stromal element could be made out in any of the sections. Sometimes about the blood vessels a fairly homogeneous, almost acellular orange staining substance was seen which contained a few orange staining chordoma cells. At times tiny columns of spindle-form connective tissue elements were seen in the vessel walls. Several of the bone fragments were sectioned, and they showed actual erosion and invasion by chordoma cells with their accompanying basophilic matrix.

Masson's trichrome, Best's carmine, and Cajal's uranium nitrate stains for Golgi apparatus were all employed on paraffin embedded sections.

The tumor cells contained large amounts of glycogen granules, and in all respects followed the histological characteristics of chordoma.

COMMENT

In 1934, Hass[2] collected twenty-five cases of cranial and cervical chordomas in which surgical removal had been attempted without much success, the tumor recurring usually within six months to a year and a half. Nevertheless, cases recorded by Klotz[3] and Bailey and Bagdsar[4] mentioned that the patients lived four and one-half and five years, respectively, after surgical intervention, and there are several cases on record in which temporary benefit has been observed after attempted removal of the growth.

The clinical and roentgen findings in our case are quite classical, since a great many of the recorded characteristic features of this neoplasm were present, namely, multiple, consecutive, unilateral, cranial palsies resulting from a middle fossa mass lesion with *x*-ray evidence of erosion of the sella and beginning penetration of the maxilla.

At operation an apparently well encapsulated tumor was found involving the left anterior cranial nerves, and the mucinous-like character of the growth when the capsule was removed was almost diagnostic of the condition.

CONCLUSIONS

Cranial chordomas are not unusually rare. They are sometimes amenable to surgical interference and very often considerable clinical improvement may follow such interference. The presence of a middle fossa lesion with multiple cranial nerve palsies and *x*-ray findings of destruction of the clivus is highly suggestive evidence that the growth may be a chordoma.

An instance of such a tumor occurring in a forty-seven year old female, who was

strikingly benefited at least temporarily by surgical intervention is recorded.

REFERENCES

1. Gardner, W. J. and Turner, O. Cranial chordomas: a clinical and pathologic study. *Arch. Surg.*, 42: 411, 1941.
2. Hass, G. M. Chordomas of cranium and cervical portion of the spine: review of the literature with report of case. *Arch. Neurol. & Psychiat.*, 32: 300–327, 1934.
3. Klotz, A. Chordome malin du nasopharynx. *Semaine d. hôp de Paris*, 7: 56, 1931. (Quoted from Gardner and Turner.)
4. Bailey, P. and Bagdasar, D. Intracranial chordoblastoma. *Am. J. Path.*, 5: 439–450, 1929.

The essential factor of the diffuse acute goiter is its rapidity of onset. The diffuseness has to do with the gross anatomy, that is, both lobes are uniformly enlarged. Bilateral uniform enlargement of the gland with an acute onset of the symptoms of thyrotoxicosis establishes the diagnosis. From—"Diseases of the Thyroid Gland. Presenting the Experience of More Than Forty Years"—by Arthur E. Hertzler (Paul B. Hoeber, Inc.).

POSTOPERATIVE GANGRENE OF THE FINGER FOLLOWING DIGITAL NERVE BLOCK ANESTHESIA

REPORT OF A CASE

CHARLES W. McLAUGHLIN, JR., M.D.
Assistant Professor of Surgery, University of Nebraska College of Medicine
OMAHA, NEBRASKA

GANGRENE of the finger following digital nerve block anesthesia is frequently mentioned as a complication of this very common surgical procedure. That it occurs very rarely is supported by the infrequent reports in the literature in spite of its wide general use. The following case is reported to emphasize certain of the hazards which must be considered when digital nerve block anesthesia is employed:

CASE REPORT

M. S., a man, fifty-two years old, was seen ten days after the development of a tender, red area at the base of the nail on the right middle finger. Examination disclosed a typical paronychia involving the base and the radial side of the nail. Surgical drainage under block anesthesia was advised.

The middle phalanx of the finger was blocked, using 2 per cent novocain with adrenalin, a total of 3 cc. being employed. The finger was seen to blanch temporarily following the injection but the color promptly returned with massage. A rubber band tourniquet was applied about the base of the digit five minutes after the novocain was introduced to provide a dry field during the operative procedure. This consisted of the usual bilateral incisions at the base of the nail with removal of a portion of the nail root. A piece of rubber dam was introduced beneath the skin flap and the tourniquet immediately removed. The operation required approximately five minutes and the tourniquet was in place only during that period of time. A small amount of bleeding occurred when the tourniquet was removed. This was encouraged by gentle massage of the proximal and middle phalanges. Warm boric acid soaks were advised for the postoperative period.

The patient immediately returned home and after preparing a boric acid solution proceeded to saturate the dressings. The temperature of the solution was not tested and apparently the finger was immersed in very hot boric acid while the digit was still anesthetized. Severe pain developed in the finger within twelve hours and persisted until the patient again reported, forty-eight hours after the operative procedure.

Examination disclosed the entire distal phalanx to be dusky and anesthetic. There was a large bullus on the dorsum of the finger extending from the base of the nail over the dorsum of the middle phalanx. The blister was cut away and all the superficial skin of the tip of the finger, including the nail, was easily removed in one piece. The underlying tissue of the finger tip was bluish-black and definitely gangrenous.

The finger was treated conservatively and in twelve days a definite line of demarcation was apparent at the junction of the middle and distal phalanges. The tissue on the dorsum of the middle phalanx remained viable, having sustained only a second degree burn.

Two weeks after the original operation the patient was admitted to the hospital and the finger amputated under gas-oxygen anesthesia. A circular incision was made just proximal to the line of demarcation, the bone of the mid-phalanx being divided at the junction of its middle and distal thirds. The flaps were loosely approximated and the tip permitted to close by second intention. Healing was complete and the patient back at full work five weeks after the amputation.

Examination during the period of hospitalization disclosed no evidence of peripheral sclerosis. Blood studies and urinalysis were normal, and the Kline and Kahn reactions were negative.

One year later the patient again reported with a paronychia on the right index finger. This was opened under block anesthesia, using .5 per cent novocain without adrenalin. The

patient was kept in the hospital for a period of two days so that the postoperative treatment could be carefully supervised. Convalescence was entirely uneventful in this instance, demonstrating an absence of any specific sensitivity to novocain.

DISCUSSION

Kaufman,[2] in a recent review of the cases of gangrene following digital nerve block anesthesia, found only one previous report of four cases in the American literature. He collected a series of twenty-five cases from the European literature, and these with the four cases reported by Garlock,[1] and one observed by himself, brought the total number to thirty. Our patient brings this total to thirty-one cases, of which only six have been reported by American observers. One cannot but doubt that this small series represents a true index of the frequency of this complication.

The contributing factors in the development of this unfortunate complication have been listed as follows: peripheral arteriosclerosis, allergic reaction to the anesthetic agent, the injection of excessive amounts of solution, vasoconstriction due to epinephrin, vascular trauma incident to the tourniquet and burns from immersing the anesthetized finger in abnormally hot solutions.

Each of these factors, or a combination of several, are sufficient to produce gangrene following digital nerve block anesthesia. In the case here reported there is little doubt that the burn from the excessively hot boric acid solution precipitated the gangrene. This was true in Kaufman's personal case and in one other in his collected series.

It is important to remember that nerve block anesthesia is a procedure that is not entirely free from danger. Small amounts of .5 or 1 per cent novocain without epinephrin should be employed and the solution injected in close proximity to the digital nerves. Tourniquets are to be avoided prior to injection, and if used to obtain a bloodless field, their application should be limited to the shortest possible period. Free bleeding should be encouraged by massage at the end of the operative procedure. When hot packs are desirable during the postoperative period, they should not be employed until the anesthesia has entirely disappeared. The temperature of the solution should be very carefully controlled by testing it on intact healthy skin. When feasible it is desirable to reexamine all patients subjected to this type of anesthesia within two hours after the operation so that the circulation of the digit may be determined and prophylactic therapy instituted when necessary.

SUMMARY

A case of postoperative gangrene of the finger following digital nerve block anesthesia is reported. The recent literature on this subject is reviewed, stressing the relatively small number of these cases present in the American literature. The injudicious use of abnormally hot, wet dressings following the use of local anesthesia is stressed as a frequent cause of this complication.

REFERENCES

1. Garlock, J. H. Gangrene of the finger following digital nerve block anesthesia. *Ann. Surg.*, 94: 1103–1108, 1931.
2. Kaufman, P. Gangrene following digital nerve block anesthesia. *Arch. Surg.*, 42: 929–939, 1941.

UNUSUAL METASTASIS OF RECTAL CARCINOMA

CASE REPORT

IRVING GREENFIELD, M.D.
Assistant Visiting Physician, Kings County Hospital
BROOKLYN, NEW YORK

VIRCHOW'S node is the lymph-node or group of lymph-nodes behind the clavicular insertion of the left sternomastoid muscle. It is near the termination of the thoracic duct at the junction of the left subclavian and internal jugular veins. In 1849, Virchow[1] called attention to the fact that metastatic growth develops occasionally in these lymph-nodes in carcinoma in the abdominal cavity. In doubtful cases of abdominal tumors, such secondary localization might be of great diagnostic value. Wood[2] stated that secondary localization in these lymph-nodes is rare with cancer of the stomach and that metastases to the left supraclavicular space in patients with adenocarcinoma of the rectosigmoid are even more rare.

In reviewing 366 cases of malignancy of the lower bowel, Bacon[3] found evidence of metastasis to one or more distant organs in 126 instances. None of this group presented involvement of the supraclavicular lymph-nodes. Buie[4] quotes Broders as stating that he had not seen a case of metastasis to Virchow's node from a carcinoma of the rectum but that the supraclavicular metastasis from such a primary focus can occur. Because of the paucity of reports in the literature of such a sequence of events, the following case report warrants presentation:

CASE REPORT

A fifty-one year old white man was first seen January 5, 1940, because of intermittent rectal bleeding, abdominal cramps and diarrhea of short duration. About two months before he came under observation he began to complain of abdominal cramps which occurred at frequent intervals daily. The cramps were of short duration and were located in the lower portion of the abdomen. The patient had been constipated for many years but since the onset of the abdominal cramps he had had a change in his bowel habits. About one month prior to the time he first came under observation, he had a small watery stool with each spasm of cramps. There was an indefinite loss of weight. He continued to work but complained of feeling tired before the end of his working day.

The past history is significant because of the fact that in 1937 the patient complained of protruding, painful and bleeding hemorrhoids. He complained of constipation and with each bowel movement, he noted protrusion of hemorrhoids. He had some rectal bleeding prior to this time and had lost five pounds in weight between January, 1937, and May, 1937. Anoscopic examination preceding the hemorrhoidectomy performed by a surgeon revealed several internal varices. He was discharged from a hospital on May 12, 1937, nine days following a hemorrhoidectomy.

The pertinent findings in the physical examination in his last illness were marked pallor, poor nutrition and loss of skin elasticity. The blood pressure expressed in mm. of mercury was 130 mm. and the diastolic blood pressure was 80. There was a small, firm, discreet, bean-sized nontender gland palpable in the left supraclavicular fossa at the sternoclavicular junction. The liver and spleen could not be palpated. There was a loss of adipose panniculus of the abdominal wall. A group of glands about the size of pigeon eggs could be felt along the mesentery. Fluoroscopic study of the chest revealed normal lung findings. There was no exaggeration of the mediastinal or hilar lymph-nodes. The heart was centrally placed. There were no abnormalities noted in the contour of any of the cardiac chambers or borders. The barium meal was seen to flow through the esophagus freely. There was a very short delay in the passage of the barium through the cardio-esophageal junction. The stomach filled in the normal manner. The outline of both curvatures of the stomach was smooth. Normal

peristaltic waves were seen to progress in normal fashion to the pyloric region. The duodenal cap was observed to fill out and empty normally. There were no gastric, pyloric or duodenal irregularities or abnormalities demonstrable fluoroscopically. These examinations were made in an attempt to visualize a primary malignant gastric focus.

Laboratory data revealed the following: hemoglobin (Sahli) 78 per cent, 4 m. erythrocytes, 47 per cent polymorphonuclear leukocytes, 48 per cent lymphocytes, 5 per cent eosinophilic leukocytes. The sedimentation of the erythrocytes was 18 mm. in fifty-five minutes. The blood Wassermann reaction was negative. The urine was normal. Procto-

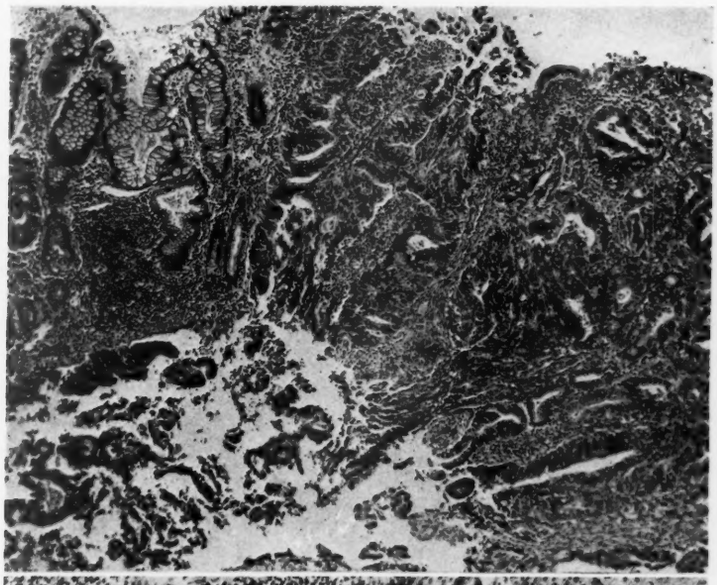


Fig. 1.

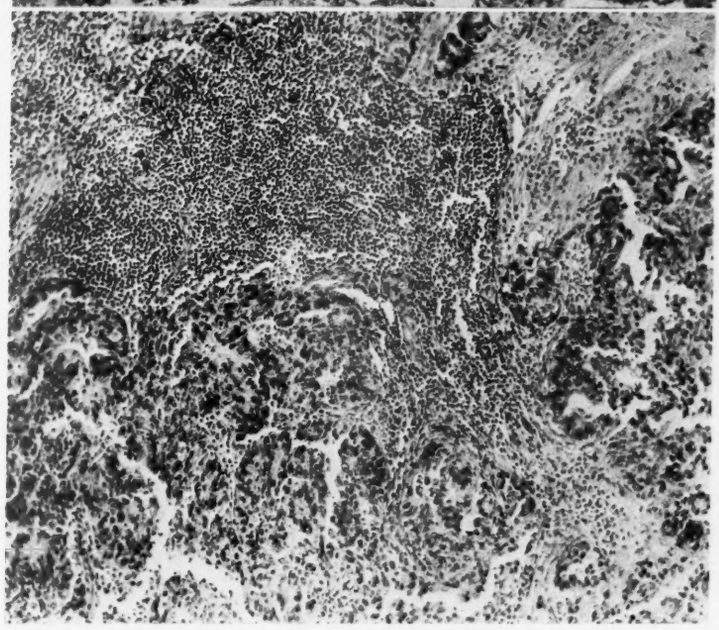


Fig. 2.

Fig. 1. Fragment of tissue removed from rectum reveals tumor tissue arising from the mucosa and invading diffusely into the underlying submucosa. × 100.

Fig. 2. Section through left supraclavicular node reveals metastatic infiltration of tumor cells of a type similar to that noted in the rectal biopsy. × 150.

sigmoidoscopic examination performed by Dr. Robert Turell revealed mixed piles. A large papillary mass about 14 cm. from the anal orifice occupied the anterior surface of the colon. Several fragments of the tumor tissue were removed from the rectum for histologic study.

The microscopic appearance (Fig. 1) of this tissue was as follows: "Sections of the fragments of tissue removed from the rectum reveal tumor tissue arising from the mucosa and invading diffusely into the underlying submucosa. Here and there abrupt transitions of the normal mucosa into the neoplastic tissue are seen. The tumor is composed of highly irregular glands lined by single or stratified layers of hyperchromatic columnar cells which in many places show evidence of changed polarity. Mitotic figures are numerous. There are scattered polymorphonuclear leukocytes, eosinophiles and lymphocytes in the submucosa."

Subsequently the patient was sent to The Brooklyn Hospital where the supraclavicular glands were removed by Dr. R. Turell. The pathologic reports were rendered by Dr. J. Arnold de Veer. The microscopic appearance (Fig. 2) of these glands was as follows:

Sections through the supraclavicular lymph-nodes reveal them to be imbedded in and partially replaced by fibrous tissue showing chronic inflammation. The lymph-nodes are occupied, too, by metastatic tumor with a pattern quite like that of the tumor in the rectum. There are highly irregular glands and solid nests of hyperchromatic columnar cells showing occasional mitoses and often surrounding cores of necrotic tissue. Tumor emboli are seen frequently in the periarterial lymphatics in the vicinity of the capsule of the lymph-nodes.

The patient's condition was poor. There was evident cachexia and dehydration. Operative intervention was suggested but refused. The patient's course was rapidly downhill. He died fourteen weeks after he came under observation. Necropsy was refused.

DISCUSSION

In order to attempt an explanation of the formation of a Virchow node in patients with carcinoma of the rectum, a review of the lymphatics of the rectum was made. According to Rouviere[5] the rectum possesses the same mucous, submucous and muscular networks as the other parts of the large intestine. Nevertheless, the rectal mucous network presents certain peculiarities; it differs, in the pelvic part of the rectum, in the pars analis recti and in the cutaneous zone below the anal valves. The mucous lymph network is more developed in the rectal than in the anal parts of the rectal mucosa. The continuity of the lymphatic network of the rectum throughout its entire extent explains why the inguinal nodes, which become swollen in cancer of the anus, may also become affected when the cancer is situated higher up. Superiorly, the mucous network of the rectum is continuous with that of the sigmoid colon; but the meshes of the network on the colic side are much larger. In the cutaneous zone below the anal valves the mucous and submucous networks are replaced by a dermal and subcutaneous lymphatic network, both consisting of a very compact meshwork. The dermal lymphatic network is particularly dense and is continuous above with the mucous lymph capillaries of the anal canal, and below with the perineal cutaneous lymphatic network of the gluteal region.

Looney[6] has demonstrated anatomically that the lymphatic system about the rectum and anus is divided into three collecting trunks: an inferior, middle and superior.

The inferior collecting trunk corresponds to the anal integument, in which the capillary networks, both superficial and deep, are extremely abundant and from which three to five collecting vessels on either side pass to the inguinal region and end in the medial superficial inguinal nodes.

The middle zone corresponds to the transition zone of the epithelium, that is, with the mucous membrane below the columns of Morgagni. Here the network is coarse and has its meshes arranged vertically, its ducts drain partly into nodes situated along the inferior and middle hemorrhoidal arteries, and partly pass to the nodes of the mesorectum, situated

along the superior hemorrhoidal artery and known as the anorectal nodes.

The superior zone corresponds to the remainder of the rectal mucous membrane and contains a rich network whose collecting vessels pass to the anorectal glands and thence along the superior hemorrhoidal artery to the mesocolic and inferior mesenteric nodes. These routes form the lymph channels described by Miles[7] as the extramural lymphatics into which the intramural and intermediary systems drain.

The intramural lymphatics consist of two freely communicative networks located within the wall; one, the submucosal, and the other, the intermuscular. These intercommunicate by radial lymph channels lying between the circular fibers. The submucosal network is to a lesser extent continuous above with the pelvic colon, and below with the subcutaneous lymph channels of the perianal skin. The main avenue of dissemination, according to Coller[8] and his associates, is through the external muscle coat to the intermediary system.

Lymph drainage differs from vascular drainages in that there may be several efferent vessels to a single node. Gilchrist[9] is of the opinion that lymphatic spread is primarily embolic. Lymph-nodes involved in this manner become blocked and act as a filter to prevent further dissemination of carcinoma cells. Lymph flow becomes static and other embolic foci may be established through collateral unobstructed channels. The direction of the lymphatic metastases depends on the direction of the lymph flow. Thus retrograde transport[10,11] of carcinoma cells may result following occlusion of lymph trunks. The most common channel for widespread dissemination of carcinoma is through the thoracic duct from which cancer cells are poured into the general circulation.

Shafiroff[12] has noted that the thoracic duct in dogs occasionally runs through a lymph-node just before its entrance into the subclavian vein. In these instances the patency of the lymph duct is interrupted by the meshwork of the lymph gland and is re-established after the duct emerges from the node. If this observation in dogs is confirmed in man, it may be a very logical explanation for the formation of the node noted in this case.

An autopsy examination was not made. In view of the entirely negative fluoroscopy of the stomach, it was not believed that the primary focus from which the gland in the neck was formed was from the upper gastrointestinal tract. The mesenteric glands were enlarged as a result of the dissemination of cancer cells from the primary focus in the rectum. The microscopic appearance of the left supraclavicular lymph-nodes resembled very closely the microscopic appearance of the tissue removed from the rectosigmoid. A diagnosis of carcinoma of the rectum with metastasis to the left supraclavicular nodes appeared justified.

SUMMARY

A case of carcinoma of the rectosigmoid with metastases to the left supraclavicular space (Virchow's lymph-node) is reported.

REFERENCES

1. Virchow, R. Die Medizinische Reform. P. 248, 1849.
2. Wood, F. C. Personal communication.
3. Bacon, H. E. Unusual sites of metastasis from carcinoma of the rectum and sigmoid colon. *Phiiadelphia M. J.*, August, 1940.
4. Buie, L. A. Personal communication.
5. Rouviére, H. Translated by M. J. Tobias: Anatomy of the Human Lymphatic System. Ann Arbor, Mich., 1938. Edwards Press, Inc.
6. Looney, W. W. Lymphatic distribution of the colon and rectum. *Am. J. Surg.*, 46: 143–148, 1939.
7. Miles, W. E. Pathology of spread of cancer of rectum and its bearing upon surgery of cancerous rectum. *Surg., Gynec. & Obst.*, 52: 350, 1931.
8. Coller, F. A., Kay, E. B. and MacIntyre, R. S. Regional lymphatic metastasis of carcinoma of the rectum. *Surgery*, 8: 294–311, 1940.
9. Gilchrist, R. K. Fundamental factors governing lymphatic spread of carcinoma. *Ann. Surg.*, 3: 4, 1940.
10. Gilchrist, R. K. and David, V. C. Lymphatic spread of carcinoma of the rectum. *Ann. Surg.*, 108: 4, 1938.
11. Westhues, H. Die pathologisch anatomischen Grundlagen der Chirurgie des Rektumkarzinoms. P. 78. Leipzig, 1934. George Thieme. Quoted by Colp, R. *Ann. Surg.*, 108: 638, 1938.
12. Shafiroff, B. G. P. Personal communication.

SPONTANEOUS HEMORRHAGE INTO THE RECTUS ABDOMINIS MUSCLE SIMULATING ACUTE INTRA-ABDOMINAL CONDITIONS

GEORGE STRENGER, M.D.

Acting Associate Surgeon, Division of Gastrointestinal Surgery, Jewish Hospital of Brooklyn; Assistant Visiting Surgeon, Welfare Hospital, New York City

BROOKLYN, NEW YORK

SPONTANEOUS hemorrhage into the rectus abdominis muscle is rare. Cullen,[2] during thirty years of surgical practice, saw only five cases. Several surgeons of wide experience have stated to the author that only a few examples of this condition have come under their observation. It simulates acute intra-abdominal disease so closely that it is rarely diagnosed before operation.

Anatomy. There are several points in the anatomy of the rectus abdominis muscle which deserve emphasis. The posterior aspect of this muscle lacks a fibrous sheath in its lower third, so that a collection of blood could exert considerable pressure against the peritoneum below the semilunar fold of Douglas. The blood supply depends largely on two vessels: The upper is the superior epigastric artery which is a continuation of the internal mammary; the lower is the inferior epigastric artery which is a branch of the external iliac. There is also some blood supply from the intercostal vessels. The epigastric vessels run in a shallow groove on the posterior aspect of the muscle, except at the level of the umbilicus where they meet in the substance of the muscle in a dense capillary and arteriolar network.[5] A double system of veins parallels the arteries.

Etiology. The immediate cause of a hemorrhage in the rectus abdominis muscle may be a slight exertion such as coughing, turning in bed or riding in an automobile over a rough road. Often careful questioning of the patient fails to elicit any specific act or trauma which might have produced the clinical picture. Degeneration of muscle and blood vessels may be the basic factor which is provocative of intramuscular hemorrhage. All of our patients were over sixty years of age. Some febrile diseases are complicated by muscle degeneration. Rudolph Virchow,[6] in 1857, described rupture of the rectus abdominis in typhoid fever and he gave a detailed account of hyaline degeneration of muscle in this disease. Rectus muscle tears were quite frequent during the influenza epidemic of 1918.[4] Hemorrhage into the rectus abdominis may be one of the complications of pregnancy.[1]

Diagnosis. The earliest and most constant symptom is abdominal pain. The location of this pain depends primarily on the site of the hemorrhage. The severity of the pain is usually in direct proportion to the size of the hematoma. The patient may notice an abdominal mass or discoloration of the abdominal skin. The leucocyte count is frequently elevated.

The physical signs depend upon the degree of intramuscular hemorrhage. Only spasticity may be present if a few small blood vessels have ruptured, and a palpable mass presupposes a sizable hemorrhage. Tenderness is quite marked and it is confined to the circumscribed area of the hematoma. The abdominal wall adjacent to the hematoma usually has no tenderness. This is an important diagnostic sign and it should help to exclude an intra-abdominal condition. A large hemorrhage produces a mass which can be felt fixed in the abdominal wall. Absence of the posterior rectus sheath below the semilunar fold of Douglas may allow extravasation of

blood downward anterior to the peritoneum and thus a mass may be palpable through the vagina or rectum. Another significant sign is ecchymosis of the abdominal skin which may be some distance away from the area of tenderness.

Treatment. Operative treatment is indicated. Bleeding points should be ligated when possible and the hematoma evacuated. Operative delay may cause progressive hemorrhage and secondary infection may then complicate the picture. Closure of the wound without drainage is preferable except in those cases in which hemorrhage cannot be completely controlled, when infection has already occurred, and when there is a large dead space.

CASE REPORTS

Case I. J. T., No. 763, a seventy-two year old seaman, was admitted to the second surgical division of Welfare Hospital, New York City, service of Dr. Louis Carp, on July 31, 1940. He had been on the medical ward for one year for the treatment of chronic myocarditis and aneurysm of the abdominal aorta. The patient complained of right lower quadrant pain of fifteen hours' duration which began during the night while he was in bed. There had been no nausea or vomiting. At the time of the surgical consultation his rectal temperature was 100°F., pulse 112, and respirations 20. The blood pressure was 120/70. He appeared acutely ill and in pain. The entire right side of the abdomen was tender, especially at a point just below the level of the umbilicus. Spasm of the right rectus abdominis muscle and generalized rebound tenderness were also present. A large pulsating mass probably aorta, could be felt in the epigastrium. The white blood count was 18,600 of which 78 per cent were polymorphonuclear leucocytes and the remaining 22 per cent lymphocytes. The blood Wassermann test was negative. The urine contained a trace of albumin and five red blood cells per high power field as well as an occasional white blood cell.

A diagnosis of acute appendicitis was made and the patient was operated upon by the author. Cyclopropane anesthesia was used. A 9 cm. vertical incision was made over the lower half of the right rectus abdominis muscle. When the anterior rectus fascia was divided, there was found just below the level of the umbilicus a hematoma about 4 cm. in diameter containing clotted and unclotted blood. Muscle fibers were torn and macerated, and the intact muscle bundles adjacent to the site of hemorrhage were gelatinous and friable. Several small blood vessels were ligated. The peritoneal cavity was then opened and the appendix was found to be normal. The aorta and iliac arteries were greatly dilated and studded with sclerotic plaques. The abdomen was closed in layers without drainage. The patient's course was uneventful except for extensive ecchymosis around the wound which gradually disappeared within three weeks.

Case II. Mrs. S. S., No. 220181, was a sixty-two year old housewife who was admitted to the surgical service of Dr. Louis Berger, Jewish Hospital of Brooklyn, on March 9, 1939, with a two-day history of pain and swelling in the lower half of the left side of the abdomen. She had not vomited and her appetite had not been impaired. For many years she had suffered from hypertension, and a year before she had been confined to bed for six months because of a severe "heart attack." She was taking a maintenance dose of digitalis at the time of admission.

Her temperature was 99°F. and her blood pressure 230 systolic and 130 diastolic. She did not appear acutely ill. Her heart was diffusely enlarged and a loud systolic blow could be heard over the entire pericordium. In the left lower quadrant of the abdomen was a mass extending from the midline toward the anterior superior iliac spine and it measured about 10 cm. in diameter. It was firm, tender and somewhat mobile. The vaginal and rectal examinations were negative. She was observed for forty-eight hours and during that time the mass increased in size and ecchymosis appeared around the umbilicus.

Roentgenologic study of the large intestine by means of a barium enema showed no abnormality. There was evidence of serious myocardial involvement on the electrocardiographic tracing. The red blood count was 3,300,000 and hemoglobin 50 per cent; there were 8,000 white blood cells of which 88 per cent were polymorphonuclears and 12 per cent lymphocytes. The sedimentation time was rapid. The blood chemistry was normal and the Kline test for lues was negative. The urine contained a trace of albumin. No occult blood was present in the stool.

The preoperative diagnosis considered were mesenteric or ovarian cyst. Operation showed a large hematoma in the left rectus abdominis muscle extending from the level of the umbilicus to the symphisis pubis and from the midline outward toward the flank. A large amount of fluid and clotted blood was present. The peritoneal cavity was opened but no intra-abdominal abnormality could be found. The abdomen was closed in layers and the cavity in the muscle was drained through a lateral stab wound. Tissue removed for microscopic examination was reported as clotted blood. The wound continued to drain sanguineous fluid for seventeen days and it was completely healed in twenty days.

Case III. C. C., No. 23714, was a sixty-two year old Italian laborer who was admitted to the surgical service of Dr. Robert Kennedy, Beekman Hospital, New York, on May 21, 1934. He had been suffering from "asthma" for many years. Following a severe coughing spell twenty-four hours before admission, he felt a sharp pain in the right upper part of his abdomen. The pain had increased steadily until the time of his admission. There had been no vomiting.

He appeared acutely ill and in pain with a temperature of 101°F. and a pulse rate of 80. The blood pressure was 142 systolic and 90 diastolic. Sibilant and sonorous râles were present in both lungs. In the right upper quadrant just below the costal margin and near the midline there was a firm tender mass 8 cm. in diameter. It was apparently fixed to the underlying tissues. The preoperative diagnosis was incarcerated ventral hernia, although hemorrhage into the right rectus muscle was suspected.

Operation was performed under local anesthesia by Dr. Myron A. Sallick who found a hemorrhage into the right rectus abdominis muscle just below the costal attachment. The muscle fibers adjacent to the hematoma were very friable. No active bleeding points were present. Exploration of the peritoneal cavity was negative. The wound was closed without drainage. The postoperative course was uneventful except for a mild staphylococcic infection of the wound.

COMMENT

The first case closely simulated acute appendicitis, and it was the most difficult diagnostic problem of the three reported cases. Neither mass nor ecchymosis was present. Additional confusion occurred because of rebound tenderness. The only suggestive sign of intramuscular hemorrhage was the limitation of spasm to the right rectus abdominis muscle. The second case was diagnosed as an intraperitoneal cyst because of the presence of a mass in the left, lower quadrant of the abdomen. The significant signs of an ecchymosis and a mass were present, but the correct diagnosis was not made because the possibility of a spontaneous hemorrhage into the rectus abdominis muscle had not been considered. In the third case the hematoma formed a fixed mass in the right upper quadrant which led to the incorrect diagnosis of incarcerated ventral hernia. All patients were over sixty years old.

SUMMARY

Spontaneous hemorrhage into the rectus abdominis muscle is discussed and three case histories are presented. In patients past middle life and in younger individuals with an acute febrile disease who present a clinical picture of varying degree characterized by abdominal pain, localized tenderness over the rectus muscle, a palpable mass and ecchymosis of the abdominal skin, hematoma of the rectus abdominis muscle is the preferable diagnosis. Operative therapy is usually indicated to control bleeding and to prevent a progressive hematoma with possible secondary infection.

REFERENCES

1. Ashkar, P. A. Spontaneous rupture of right rectus muscle in pregnancy. *Lancet*, 2: 934–935, 1939.
2. Cullen, T. S. and Brodel, M. Lesions of the rectus abdominis muscle simulating an acute intra-abdominal condition. *Bull. Johns Hopkins Hosp.*, 61: 295–348, 1937.
3. Payne, R. L. Spontaneous rupture of the superior and inferior epigastric arteries within the rectus abdominis sheath. *Ann. Surg.*, 108: 757–768, 1938.
4. Snyder, W. H., Jr. Spontaneous hematoma of the abdominal wall following respiratory infection. *Calif. & West. Med.*, 50: 25–28, 1939.
5. Trophinoff, A. M. Quoted by Payne.
6. Virchow, R. Ueber Entzundung und Ruptur des M. rectus abdominis. *Verhandl. d. phys.-med. Gesellsch.*, 7: 213, 1857.

IMPLANT SKIN GRAFTING*

CASE REPORT

WILLIAM S. S. HORTON, M.D.
Adjunct Surgeon, Long Beach Hospital
LYNBROOK, NEW YORK

ON December 19, 1940, a boy of nineteen years was admitted to the Surgical Service of the Long Beach Hospital. He stated that five days before after siphoning a gas tank, he struck a match and his trousers caught on fire. He was treated at home by his family physician for third degree burns of the left leg for five days, but because the burn failed to respond to treatment, hospitalization was advised. The patient also stated that since he was a child he had had heart trouble and that only about two years before he had been confined to bed because of a heart attack.

Physical examination revealed that the heart was enlarged and at all valve areas there was systolic and diastolic murmurs characteristic of an old rheumatic heart disease. There was a third degree burn of the lower left extremity. This burn extended from the upper one-third of the thigh to just below the ankle joint. There was a thick crust over the leg, which was assumed to be tannic acid spray. At the upper one-third of the thigh directly above the burn on the external lateral surface there was a large indurated area. There was much necrotic tissue. On admission diagnosis was third degree burn of the entire left leg; rheumatic heart disease.

From the time of admission until January 14, 1941, local treatment was instituted to clear up the infection in the leg. All this time the patient had been running a toxic temperature. Many intravenous injections of 5 per cent glucose and saline were given. Vitamins and liver extract were given and his diet was a high caloric one.

From January 14, 1941, to February 14, 1941, three skin grafting operations were performed but they were not successful. He seemed allergic to the grafts. On April 9, 1941, the case was turned over to me for consideration and implant skin grafting on a massive scale was decided upon.

At operation on April 11, the left leg from thigh to ankle was covered with hot saline gauze dressings for two days. At this time the patient was considered a very poor risk on account of his cardiac and toxic condition. He had lost considerable weight.

Under cyclopropane anesthesia the left leg, on the anterior surface, was cleansed of its crust from the thigh to the ankle. Considerable bleeding occurred. From the right anterior thigh, a Thiersch graft 5 by 2 inches was removed with a razor. This graft was placed in a pan of sterile normal saline, then transferred to a sterile bass wood splint 4 by 10 inches which had been moistened with normal saline. With a sharp razor this large graft was cut into pieces one-quarter an inch square and left on the splint.

One of these small pieces was removed from the splint, placed with its freshly cut surface on the granulation tissue and tucked into the granulation tissue as you would tuck a letter into an envelope. Two large needles were used. They were reversed with points in artery clamps. The eye ends were employed to tuck the small graft in place, leaving just a small point protruding; the one needle kept the graft in place upon withdrawal of the other needle.

The grafts were tried at all depths and all positions; one hundred fifty grafts were placed at this operation on the anterior surface from thigh to ankle, and fully 90 per cent of the implants grew. Operating time lasted one hour. The grafts were covered with parawax gauze. Moist saline compresses were applied over the wax gauze and were changed several times a day.

For about one week no growth was visible and then many white skin islands began to appear from thigh to ankle. In the picture taken posteriorly it can be seen that the grafts are beginning to push their way up through the granulation tissue and to spread joining with the adjacent grafts. All stages are represented in this picture. (Fig. 1.)

* From the Department of Surgery, Long Beach Hospital, Long Beach, L. I.

On the anterior picture of the leg the junction of the new fibroplastic implants to the existing skin can be seen. There is a smooth line of junction with no contracture and no raised edge. Only a faint white line at this site can be noticed. (Fig. 2.)

Considerable hemorrhage occurred at the sites of the communicating veins when disturbed by implanting grafts, but fibroblastic tissue gradually grew around the elevations, depressed and finally completely epithelialized them. There was no attempt at this operation to plant the skin grafts in a symmetrical manner. They were implanted in areas that would give us the least possible hemorrhage. Later on the grafts were implanted in the lines of squares but it did not seem to me that there was any difference in the manner, time or the extent of growth as compared with the first method of implantation.

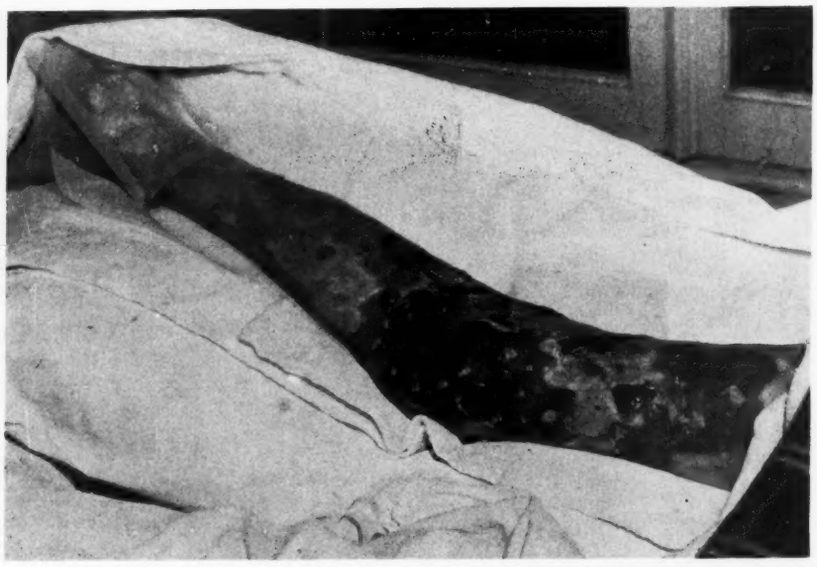


Fig. 1. Posterior view six months after initial grafting.

The picture of the posterior surface of the leg was taken on October 8, 1941, and one month afterward all areas were healed and patient was up on crutches. Physiotherapy should now be instituted to restore the leg to normal function.

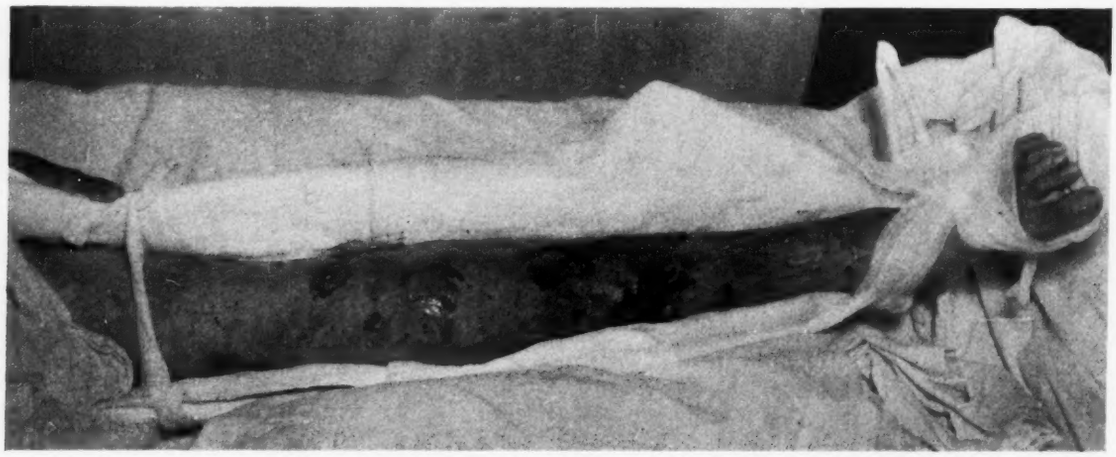


Fig. 2. Anterior view six months after initial grafting.

There were six implant operations from April 11 to September 22, 1941. There was a total of 650 implant grafts used. Twelve transfusions of 500 cc. each of citrated blood were given from January 6 to September 18, 1941. There were sixteen complete blood counts which showed a rather moderate leucocytosis. Many urinalyses were done. Blood cultures

were negative for twenty-four hours and for one week. Repeated cultures from the left leg showed a Gram-negative cocci resembling staphylococcus, also short chain nonhemolytic streptococci.

CONCLUSIONS

I believe that by using this technic grafts can be implanted earlier. This type of massive implant is particularly valuable in burns with large denuded areas because the burned areas will be epithelialized more quickly and the hospital stay shortened. One important factor to be observed in these operations is that they should be done in subdued light to avoid the heat killing of the grafts. There is one question yet to be answered: Will the pigmented layer of the skin grow under the fibroblastic implant and in time match the normal skin?

This method would be of inestimable value in the cosmetic treatment of facial burns with much loss of tissue. The earlier the implant the less contracture at the line of demarcation.

This is only a preliminary case report. As more cases are dealt with and we acquire more experience with this method, I believe that operative procedures and hospital stay can be markedly shortened, thus rehabilitating patients more quickly than with other methods.

This technic would be quite valuable in case of war, especially in the bombing of the civilian population in which hundreds of cases of major burns would occur.

The method and technic of implant grafting is quite simple, the after-care is not complicated and the results are fairly good. There is very little fibroblastic contracture in the implants at the present time. It would seem that the co-efficients of expansion and contraction of the fibroblastic layer and the inflammatory tissue are the same, therefore, there is no contracture at the line of junction with the existing skin. The edge of the existing skin was not freshened at the line of junction; the fibroblastic implants just merged with hardly a line of demarcation and there was no raised edge and no contracture.

REFERENCES

1. Marcks. Implantation grafts. *Am. J. Surg.*, 51: 361, 1941.
2. Pollack, A. G. Case of skin grafting and skin implantation. *Tr. Clin. Soc., London*, 4: 37, 1871.
3. Braun, Wilhelm. Zur Technikder Hautpropfung. *Centralbl. f. Chir.*, 52: 1555, 1920. Über Haut profungen. As quoted by Wangensteen. *Klin. Wchnschr.*, 14: 335, 1921.
4. Wangensteen, O. H. The implantation method of skin grafting. *Surg., Gynec. & Obst.*, 50: 634, 1930.

MIGRATING FOREIGN BODY

FRANK FONCANNON, M.D.
On Surgical Staff, Newman Memorial Hospital
EMPORIA, KANSAS

CASE REPORT

MR. H. P. G., age fifty years, entered Newman Memorial Hospital following an automobile accident on April 12, 1939. He received a fracture of the upper third of the left fibula and tibia and of the right patella. He was suffering from concussion of the brain with accompanying shock. The fracture of the leg was reduced and five days later the fractured patella was repaired surgically. At the time of admittance there was a laceration one inch in length in the midscapular line at the level of the tenth dorsal vertebra. No foreign body could be felt with a probe. There were no other lacerations of the chest wall.

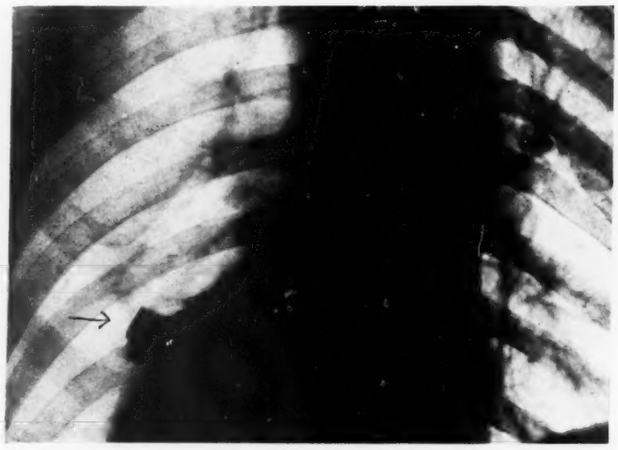


FIG. 1. Roentgenogram showing glass fragment.

FIG. 2. Lateral roentgenogram showing end-on view of fragment.

FIG. 3. Photograph of fragment after removal from anterior chest wall.

The patient complained of pain in the left chest posteriorly and a few days after the patellar operation a roentgenogram was made

of the chest. This revealed a triangular shadow at the level of the ninth dorsal vertebra. (Fig. 1.) The lateral view gave an end-on shadow of the foreign body. (Fig. 2.) Diagnosis was made of a foreign body, probably glass and possibly intrapleural. As the patient was a frail individual it was thought best not to subject him to operation at once, especially as the pain was lessening and there was no general reaction.

He was sent to his home to be under the care of the family physician. He was told to return if he had any trouble. This he did not do until nine months later. He then returned with a swollen inflamed area in the midclavicular line above the left nipple. This was opened under a local anesthetic. There was no pus but the blade of the scalpel came in contact with a hard, unyielding mass which gave off a metallic click. The object was grasped with a pair of forceps but could not be dislodged. The incision was enlarged and disclosed the end of a fragment of glass protruding between the third and fourth interspace of the ribs. The fragment was rotated which made its removal possible. The fragment measured two and five-eighth inches in length, one inch in diameter at its base and was one-fourth inch thick. (Fig. 3.)

It is evident that the fragment migrated from the posterior position up through the pleural cavity to an anterior position and worked its way through the third interspace. The patient states that he had an occasional pain, not severe, and that he noticed after weeks went by that the pain moved higher up toward the left nipple. His convalescence was uneventful. It is regrettable that a film was not made just before removal of the glass.

MASSIVE FATAL RECTAL HEMORRHAGE FROM CAPILLARY OOZING*

CASE REPORT

D. A. MacGregor, M.D.
WHEELING, WEST VIRGINIA

IT is a well recognized fact that there is a wide variation in the responses of different patients to similar painful stimuli. Frequently we are annoyed by the loud complaints of hypersensitive individuals who grossly exaggerate the suffering which they experience from minor ills and injuries. On the other extreme is the patient who has little complaint to make even though he is beset by a serious illness or accident. Apparently some of these patients bear their pain with Spartan bravery. In other patients I am convinced that the mechanism of pain appreciation is not normally responsive and these individuals actually do not experience pain in the usual manner. The problem of diagnosis is much more difficult in this inarticulate group. It does not make much difference whether the lack of response to painful stimuli is due to a determined stoicism or to an aberration from the normal process of pain appreciation.

By way of illustration I have in mind one particular patient, Mr. X, whose death may have been brought about because of the fact that he did not experience pain in the usual manner, or if he did experience it, he did not betray it in a convincing manner to his examiner. It is the story of a case of acute appendicitis which passed unrecognized by one of the most competent and conscientious general practitioners of my acquaintance. It ill becomes any of us to lift a critical eyebrow at the mention of an unrecognized acute appendicitis. There are few physicians of any considerable experience who have not had the same tragic experience, not once, but several times. Those of us who watched this particular patient through his many weeks of hospitalization marvelled at the fact that he complained of practically no pain in spite of several surgical manipulations and many unusual complications.

Mr. X was a well developed man, fifty years of age, who enjoyed good health practically all of his life with the exception of one attack of typhoid fever in 1905. His right hip was fractured in a train accident several years ago. He never had any previous surgical experience. He enjoyed his usual good health and continued actively at his work up until seventeen days before his admission to the hospital. On the day his illness began he went to work as usual but about noon he began to experience a mild, hunger-like pain in the lower abdomen. The discomfort began in the middle of the abdomen but moved over toward the right lower quadrant later in the day. It never became sharply localized at any point. He ate his noon lunch in spite of the fact that he felt nauseated. In the course of the afternoon he felt weak and tired. About 4 P.M. he went home and went to bed. Later in the evening he vomited the food which he had taken. That night he felt feverish. Later he perspired and had a shaking chill. There was no diarrhea, hematuria or dysuria. The patient remained about the same the next day. He vomited a second time in the course of that day. During the subsequent interval, prior to his admission to the hospital, he was never acutely ill. On the other hand, he did not feel strong enough to go back to work. He had a fever of one or two degrees each day, felt weak, and had no appetite. On close questioning, he admitted a mild constant discomfort in the lower right quadrant. Sometimes mild tenderness could be elicited on palpation but at other times deep pressure seemed to cause him no particular distress. His physician was at a loss to explain

* Read at the Wheeling Clinic Staff Conference, June 10, 1941.

his continued fever. He had in mind the possibility of appendiceal abscess, but the picture was not convincing. It resembled a typhoid state. Faced with a fever of undetermined origin, his physician sent him to the hospital for investigation.

When we first saw the patient and heard the story of his illness, the possibility of appendiceal abscess was foremost in our minds. The patient rather grudgingly admitted vague discomfort in the right lower quadrant. Otherwise, he had no complaints and indeed seemed rather vigorous. We could find no mass. At times there was a little tenderness on palpation but it was not constant. Rebound tenderness was so mild as to be unconvincing. There was no appreciable muscular rigidity. Thinking of the possibility of a pelvic abscess, a rectal examination was done but that yielded absolutely no positive findings. The urinalysis was negative as well as the Widal and the agglutination tests for undulant fever. The routine blood count suggested a mild pyogenic infection and a moderately severe secondary anemia. It was as follows: red blood count, 3,970,000; white blood count, 11,600; hemoglobin, 65 per cent; polymorphonuclears, 82 per cent; lymphocytes, 18 per cent.

In view of the pronounced secondary anemia and the rather vague symptoms in the right lower quadrant we asked to have the colon visualized by *x*-ray having in mind the possibility of a neoplasm involving the cecum. At the same time we asked for an *x*-ray study of the chest. The report by Dr. C. H. Clovis from the *X*-ray Department was as follows:

"Stereoscopic radiographic study of the chest shows multiple well healed tubercles throughout both lungs having the appearance of an old healed miliary T. B. There is no evidence of new lesions in the lungs. The heart is moderately enlarged to the left.

"Study of the colon by barium enema reveals a filling defect in the neighborhood of the cecum involving the gut for about three or four inches. The appearance is that of an external pressure, possible newgrowth or appendiceal abscess.

"*X*-ray diagnoses:

1. Old well healed T. B. of the lungs.
2. Heart slightly enlarged to the left.
3. Defective filling of the cecum and first portion of the ascending colon.
4. Probable walled-off abscess, possible newgrowth."

At this point in our study of the case there seemed to be no reason for further delay in requesting surgical assistance. Dr. R. B. Bailey was called in consultation and made the following observations: "The history is very suggestive of appendicitis, the barium enema shows a definite lesion about the cecum. The patient is very tender over the cecum. Probable diagnoses: one, walled-off appendiceal abscess; two, inflammatory typhilitis (similar to the pathology of terminal ileitis); three, carcinoma of cecum with perforation. Advice—exploration."

The abdomen was opened by Dr. Bailey on the twenty-second day of the patient's illness. He found a large appendiceal abscess in the right colic gutter. There was no attempt to explore the remaining viscera after the abscess was encountered. The abscess was drained and a large rubber tube, together with two iodoform packs were inserted. The packs were necessitated by the presence of oozing from the abscessed wall. No part of the appendix was identified at the time of the operation.

The patient's immediate postoperative course was quite stormy. On the second and third postoperative days the temperature went above 104°F. At this time blood transfusions, sulfathiazole and Wangensteen drainage were instituted. During the period of hospitalization the patient was given a transfusion about every fifth day. Sulfathiazole was administered for approximately one week at the rate of 15 gr. every four hours. The patient seemed to have recovered quite nicely from his operation after ten or twelve days but he continued to have a daily temperature elevation to 99.5 or 100°F. At the end of two weeks the drain was removed and for a few days the patient seemed to be in such good health that we were sure he would recover. For two whole days the temperature remained normal.

We were disappointed and chagrined when the fever returned and the patient again appeared ill about the twentieth day after operation. He was subjected to repeated physical examinations by different men on the staff. Each examination yielded negative results. The patient never complained of pain or tenderness. There was no palpable mass at any time. Occasionally he exhibited abdominal distention but most of the time the abdominal walls were flaccid. Repeated blood cultures were negative. Several examinations of the chest were made with no pathological findings.

In spite of transfusions, his secondary anemia persisted and his hemoglobin touched 55 per cent. Sulfathiazole was administered in the dosage mentioned above for another week. It had little or no effect upon the temperature. Several stool examinations were negative for occult blood. Urinalyses cast no light upon the problem. In the sixth week after operation we noticed for the first time that the patient was jaundiced. The observation was confirmed by finding the icteric index to be thirty-five. Throughout the entire period the patient complained of no pain or tenderness. As a matter of fact, he became rather listless and drowsy. We asked for a blood urea determination and found it to be normal.

One night a few days after the jaundice appeared the patient complained of discomfort in the right flank. This was perhaps his one and only real complaint at any time. We could make out nothing unusual on examination but the next day the incision opened up unexpectedly and a very large amount of pus and bile drained out. Because of the great amount of bile drainage, he was given vitamin K with bile salts. In addition, sodium chloride was given in an attempt to combat the low blood chloride content which would inevitably result from a persistent bile drainage. The blood chlorides were estimated at 225 mg. per 100 cc. at the beginning of this treatment. It is interesting to note that they returned to normal within three days after the institution of treatment with sodium chloride. We were interested to note that this result was accomplished solely by the oral administration of sodium chloride.

In the days immediately following the sudden drainage of this large amount of bile and pus from the incision the patient began to manifest considerable clinical improvement. We were dismayed by the appearance of this quantity of bile. We considered the possibility of a liver abscess which had ruptured and drained in this dramatic fashion. We also considered the possibility that the patient had had an empyema of the gallbladder and that the gallbladder instead of the appendix might have been the offending organ. While we waited and watched for new developments, the patient remained quite comfortable though very weak. His hemoglobin remained low (60 per cent). The icteric index remained at thirty. He continued to have daily temperature elevations to 101°F. The fact that the patient did not get worse, even though actual improvement was not noticeable, encouraged a more hopeful attitude. He continued to feel fairly well for ten or twelve days and then suddenly without the slightest warning he had a massive hemorrhage per rectum. According to the nurse's notes, there were five bed pans half full of blood clots. He was given three transfusions on the day of the hemorrhage. Each transfusion consisted of 700 cc. of whole blood and on the following day he was given a similar transfusion. In spite of this energetic treatment the hemoglobin was registered at 59 per cent after the fourth transfusion. Other smaller hemorrhages followed in the next few days. These hemorrhages, which occurred during the last week of the patient's life, were probably not due to a deficiency of vitamin K. The prothrombin clotting time was found to be normal when estimated by Dr. M. A. Shilling who supervised the clinical care of this patient during his entire postoperative course. The patient's shock was fairly well controlled by multiple transfusions, but the bleeding per rectum continued intermittently and the patient succumbed on the fourth day after the massive hemorrhage.

Why did this patient have hemorrhages from the rectum? What pathological entity could account for (1) a walled off retrocecal abscess? (2) an enormous amount of bile drainage through the abscessed cavity? and (3) fatal hemorrhages from the rectum? We discussed this problem at great length. Not one of us was able to offer a satisfactory answer before we received the following report from the pathologist, Dr. H. G. Little:

"The body is that of a well developed white male adult. There is a slight icteric color in the skin. There is an incision in the right abdominal wall in which there is a drain that extends into the abdominal cavity in the region of the cecum.

"On opening the peritoneal cavity there is found a rather thick purulent exudate in the pelvic cavity and scattered fibrinous exudate over the serosal surfaces of the intestines. The purulent exudate originates around the cecum. Here the cecum is firmly adherent to the parietal peritoneum and further examination discloses that most of the appendix has entirely disappeared in the mass of adhesions

and purulent exudate. Extending upward retroperitoneally from the base of the cecum, the purulent exudate has separated the peritoneum from the lateral abdominal wall. The exudate continues upward to the region of the portal vein. Following the right branch of the portal vein the exudate is traced to a large abscess involving almost the entire right lobe of the liver. The liver tissue is necrotic and considerable purulent exudate is present. The walls of the abscess are not well defined and the border extends slightly into the left lobe of the liver.

"The portal vein is not thrombosed. There are soft, enlarged lymph-nodes around the common bile duct, also the retroperitoneal and the mesenteric lymph-nodes are enlarged.

"At the brim of the pelvis there is a nodular mass in the mesentery attachment to the colon. On section this mass, grossly, consists of fat and fibrous connective tissue. The colon adherent to this mass shows no ulceration of the mucosa.

"The spleen is larger than normal. It is soft and boggy.

The gastrointestinal tract shows no tumors.

"The kidneys are normal in size and on section the markings are distinct and, grossly, no pathological changes are noted.

"Examination of the lungs showed no pneumonia. There is moderate congestion of the lower lobes of the lungs.

"The heart is normal in size and, on section, the myocardium is firm, the valves are normal.

"Culture from the pus in the liver showed some streptococci and B. pyocyaneus.

"In summary, this case was apparently a primary appendiceal abscess with the infection extending upward and into the liver to form the liver abscess.

"*Microscopic Examination.* Examination of the mesenteric nodule shows it to be composed of fat in which there is diffuse chronic inflammation. The lymphocytic and mononuclear infiltration extends into the musculature of the colon. The vessels in the submucosa and the capillaries of the mucosa are congested. Since this area in the colon was the only portion that showed any lesions, it is possible that there was bleeding from the congested capillaries in the mucosa. The nodule was of sufficient density to cause considerable localized pressure.

"*Anatomical Diagnoses.* 1. Primary periappendiceal abscess with extension through parietal peritoneum. 2. Abscess of right lobe of liver. 3. Fibrinopurulent peritonitis with effusion. 4. Localized congestion of the capillaries of the colon with hemorrhage."

SUMMARY

We have related the unfortunate history of an unrecognized case of gangrenous appendicitis in an individual whose appreciation of pain was remarkably dull. The pus from the appendiceal abscess perforated the parietal peritoneum and travelled upward to the liver. Extending along the right branch of the portal vein the infection produced an enormous liver abscess which later ruptured and drained through the appendiceal incision. Further extension of the infection proceeded by the retroperitoneal route toward the pelvic brim. The mesentery was involved and in one particular area an inflammatory tumor developed. This tumor was adjacent and adherent to the sigmoid. The wall of the sigmoid was edematous and congested at the area of contact. No open lesion of the sigmoid or in fact any portion of the intestinal tract could be demonstrated at autopsy and yet this patient expired as a result of a massive rectal hemorrhage. The remarkable feature of the case is the fact that such a large quantity of blood reached the lumen of the bowel through an intact but congested mucosa. Capillary oozing of this character is frequently noted in the stomach resulting in the so-called coffee-ground vomitus. In our experience such bleeding on an extensive scale is rarely seen in the lower end of the intestinal tract.

REMOVAL OF INTRAPLEURAL FOREIGN BODY UNDER THORACOSCOPIC GUIDANCE*

CASE REPORT

GEORGE WILLAUER, M.D. AND RICHARD J. CHODOFF, M.D.
Assistant Surgeon, Jefferson Hospital — Assistant in Surgery, Jefferson Hospital
PHILADELPHIA, PENNSYLVANIA

CASE REPORT

J. B., a white male of twenty-six, was referred to Jefferson Hospital on May 12, 1941, from a Pennsylvania sanatorium.

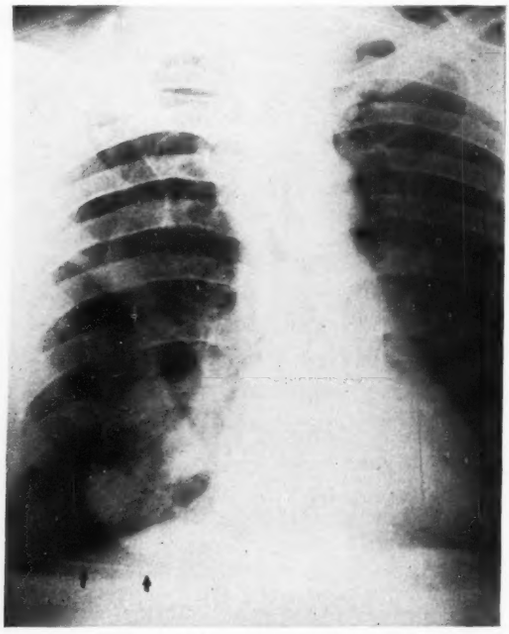


FIG. 1. Preoperative *x*-ray of chest showing needle *in situ*.

He had been receiving therapeutic pneumothorax for pulmonary tuberculosis since November, 1939. On May 6, 1941, while receiving a pneumothorax refill the needle broke off at the hub and lodged in the chest wall. An incision was made and removal of the needle attempted. During the course of the procedure the needle was forced into the pleural cavity and lodged in the posterior portion of the right costophrenic sinus. A small amount of fluid developed.

On May 14, 1941, under local anesthesia a thoracoscope was inserted into the pleural cavity in the eighth interspace posteriorly. The needle was visualized partially imbedded in the chest wall of the costophrenic sinus. The needle was partially covered with fibrin and there was some inflammatory reaction around it. A second trocar opening was made anteriorly just above the diaphragm and a Jackson type of bronchoscopic grasping forceps was introduced. Under thoracoscopic guidance the point of the needle was seized and it was withdrawn through the anterior trocar opening. The openings were closed with interrupted black silk sutures. The patient's course was uneventful and he was sent back to his sanatorium on May 17, 1941.

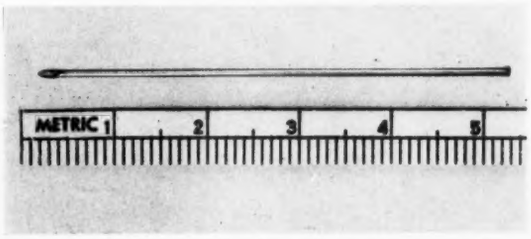


FIG. 2. Photograph of needle after removal.

COMMENT

Since closed intrapleural removal of foreign bodies is a relatively rare procedure we believe this case should be on record. There are several lessons taught in this instance which should be stressed. It is highly important that pneumothorax needles be of the finest grade of rustless steel and that needles be carefully examined and tested before using. The needle we removed was of a poor grade of ordinary steel needle and was rusted through at the hub. Secondly, embedded foreign bodies in the chest wall as elsewhere, had better be left alone until expert surgical attention and proper fluoroscopic guidance are available. Lastly, this case illustrates that where the facilities are available, intrapleural foreign bodies can be removed without subjecting the patient to the hazards of a major thoracotomy.

* From the Jefferson Hospital, Department for Diseases of the Chest, Philadelphia.

ALLERGIC REACTION FOLLOWING BLOOD TRANSFUSION

APPARENT DESENSITIZATION OF RECIPIENT

ROBERT E. S. YOUNG, M.D.
Senior Surgeon, White Cross Hospital
COLUMBUS, OHIO

NO method of blood transfusion has ever been devised that is not followed by occasional reactions. Some of the reactions can be ascribed to a certain cause; more often the cause remains obscure. Reactions are manifested by fever, malaise, nausea, vomiting, chilly sensations or actual rigor, muscular pains, dyspnea, cyanosis, pruritis, urticaria, headaches, icterus, suppression of urine, hemoglobinuria and casts. The increase in temperature may vary from 2 to 10°F.

Ramirez[1] described passive transmission of sensitivity to horse dander by transfusion. The recipient was permanently sensitized.

Carrington and Lee[2] reported a transfusion reaction that followed the administration of 50 cc. of compatible blood. Dyspnea, laryngeal stridor, cyanosis and pulmonary edema developed, and the patient became comatose and died. There was no hematuria or hemoglobinuria.

Bottner[3] cited several instances of reaction to transfusion which, because of their nature, the presence of eosinophilia and the fact that the transfusion occurred three to six weeks after the first, indicated that the reactions were allergic. Gray[4] reported a case in which liver eaten by the donor produced urticaria in a sensitive recipient. Holder and Diefenbach[5] and Tedstrom[6] reported the passive transmission by transfusion of allergy to strawberries. Littlefield[7] and Hancock[8] reported passive transmission by transfusion of allergy to eggs.

Kordenat and Smithies[9] state that so-called "anaphylactic reactions" are really due to protein shock which may occur in one of two ways: (1) the donor's blood may increase the protective or cleavage action of damaged tissue which produces the reaction; (2) because of poor proteopexic ability of the liver, partly altered proteins leak through, resulting in parenteral cleavage and nonspecific protein shock (Widal crisis).

Three cases are here reported in which various donors were used for transfusion and following each transfusion an allergic reaction occurred. An apparent desensitization is also described.

CASE REPORTS

CASE 1. A man, aged sixty-six, had been suffering from a perinephric abscess of two months' duration. Hemolytic staphylococcus aureus had been cultured from the pus. He had had a continuous spiking fever for two months and was considered seriously ill. When first seen he was dehydrated and the hemoglobin was only 54 per cent (Sahli) and the red blood cell count was 2,100,000. It was decided that he should have repeated transfusions until the hemoglobin was above 80 per cent. The patient belonged to Group III Moss. All transfusions were given slowly by the indirect method using citrated blood. The patient was retyped before each transfusion and each time still belonged to Group III Moss.

Transfusion, August 9, 1938. The donor belonged to Group IV Moss (universal donor). Six hundred cc. of whole citrated blood was given. Following the transfusion urticaria developed. On questioning the donor admitted that he had never eaten tomatoes because they made him ill. The recipient had had tomatoes for dinner. The reaction was considered to be allergic.

Transfusion, August 10, 1938. A fasting donor, belonging to Group IV Moss, was used. Approximately 100 cc. of whole citrated blood had been given when urticaria developed. The transfusion was immediately stopped and

adrenalin was administered. The patient complained of headache, his temperature rose to 104°F., and he became irrational.

Transfusion, August 12, 1938. The scheduled donor did not arrive and the mental state of the patient was such that he was not acquainted with the fact. The blood remaining from the transfusion of August 10, 1938, was taken from the ice-box, and 10 cc. given, with adrenalin at hand ready for use. This transfusion was given with the thought that it could be discontinued immediately if urticaria developed, and the patient would thus be spared the knowledge that his friend, the donor, had deserted him. However, urticaria did not develop, and the transfusion was continued until 400 cc. had been given with no reaction whatever. This was the same blood that two days previously had produced such a severe reaction.

Transfusion, August 15, 1938. The donor belonged to Group IV Moss. After 500 cc. had been given, urticaria developed and adrenalin was administered. The transfusion was continued until 700 cc. had been given. The urticaria was present for three hours after the completion of the transfusion.

Transfusion, August 16, 1938. It was decided to discontinue the use of the universal donor and for this transfusion a donor of Group III Moss was used. The cross-match was perfect. Fifty cc. of whole blood was given. Adrenalin was administered three times during transfusion because of urticaria.

Transfusion, August 18, 1938. A donor of Group III Moss was used. The cross-match was perfect and 150 cc. of citrated whole blood was given. A severe reaction followed, the temperature reached 104.5°F., the patient became irrational, and adrenalin was given. The remaining blood was placed in the ice box.

Transfusion, August 19, 1938. Up to this time, the only transfusion that had not been followed by urticaria was the one in which blood that had been kept in the icebox was used. For this reason the remainder of the blood that had produced a severe reaction on August 18th was taken from the icebox and 750 cc. of this blood was given with no reaction whatsoever.

Transfusion, August 20, 1938. The donor belonged to Group IV Moss. Urticaria developed after 600 cc. of citrated whole blood had been given.

Following the last transfusion the hemoglobin was 104 per cent, the red blood cell count was 5,000,000 and the patient was much better symptomatically. His fever began to disappear and he gained strength. The blood smear showed an eosinophilia at all times. The urine showed from 0 to 15 mg. of albumin. At no time was there hemoglobinuria.

Case II. A woman, aged sixty-five, recovering from a resection of the bowel for carcinoma of the colon, was suffering from mild shock and a transfusion was ordered. The patient was Group II Moss with no allergic history.

Transfusion, September 3, 1940. The donor belonged to Group II Moss. Five hundred cc. of whole citrated blood was drawn. After 50 cc. of blood had been given, urticaria developed and the patient suffered a chill. The transfusion was stopped. On the following morning the remainder of the blood, 450 cc. was given without reaction.

Transfusion, September 16, 1940. The donor belonged to Group II Moss. Five hundred cubic centimeter of blood was drawn. Urticaria developed after 100 cc. had been given. The transfusion was stopped and the remainder, 400 cc. was given the following morning without reaction.

Case III. A man, aged twenty-nine, recovering from a crushing injury of the abdomen, was suffering from severe shock and a transfusion was ordered. The patient was Group II Moss, and gave no history of allergy.

Transfusion, December 11, 1940. The donor belonged to Group II Moss and had no history of allergy. After 100 cc. of whole citrated blood had been given urticaria developed. The transfusion was stopped, and the remainder of the blood, 400 cc., was given the following day without reaction.

Polayes and Lederer[10] have listed the causes of transfusion reactions. Their outline has been followed in an effort to find the reason for the reactions in the cases reported here.

1. Incompatibility between donor's and recipient's blood (3 causes).

(a) Errors in grouping the blood due to the following causes in order of importance:

1. *Poor technic:* The blood was typed by the regular, trained technician

and checked by myself. There were no similar reactions occurring in the hospital.

2. *Use of low titered or contaminated test serum:* The serum used was collected from relatively high titered donors and was definitely not contaminated.

3. *Weak agglutinins or agglutinogens in the recipient's blood.* Agglutination occurred quickly. The patients belonged to correct Groups.

4. Pseudo-agglutination: The patients naturally would have a rapid sedimentation rate, but the grouping was done microscopically.

5. *Auto-agglutination:* This was definitely not present.

6. *Anomalous or atypical agglutination:* The agglutination was done with warmed serum.

7. *Contamination of recipient's blood by bacteria:* The blood may have been contaminated, but, since it was fresh, significant growth could not have occurred.

(*b*) *Indiscriminate use of universal donor:* Reactions occurred with donors of the same group as well as with a universal donor. The reactions were allergic in type. A universal donor was used in one of the two transfusions in Case I that was not followed by a reaction.

(c) *Immune iso-antibodies and hemolysins:* The recipient had never had a transfusion prior to this illness.

II. *The use of unclean apparatus:* The apparatus was clean; no new rubber tubing was used.

III. *The use of citrate solutions:* A highly controversial question. The blood that was given without a reaction was citrated. Skin tests with citrate solution produced no reaction.

IV. *Incipient coagulative changes in transfused blood:* The reactions were not of this type.

V. *Allergic phenomena in recipient.* None were present, but were present in the first donor of Case I. The reactions were allergic in character.

VI. *Systemic diseases in the recipient.* Reactions based on the presence of systemic diseases occur in patients with renal disease or renal disease develops as a result of the reactions. Pyelograms, renal and urine studies of this patient showed no renal disease, and renal disease never developed nor did the patient ever pass abnormal urine. Because of the character of the reactions they were considered to be allergic.

COMMENT

Six donors were used for eight transfusions to the same recipient in Case I. When the blood was first used, a reaction followed in each instance. In two instances in which the reactions were severe the remaining blood was placed in the icebox for forty-eight and twenty-four hours, respectively. When the blood was used a second time, no reaction occurred. This represents either a desensitization of the recipient or a "detoxification" of the blood by standing in the icebox. These two possibilities were investigated. Blood was drawn from a donor belonging to Group III, citrated, and placed in the icebox. After forty-eight hours another sample of blood was obtained from the same donor and citrated. Three intradermal injections of 0.1 cc. each of forty-eight-hour old citrated blood that had been standing in the icebox, of fresh citrated blood and of citrate solution were made on the flexor surface of the fore arm of the patient described in Case I. There was no reaction to the citrate solution. A wheal of pseudopods quickly formed at the site of the injections of both the old and fresh blood. The wheals were 1 inch to 1.5 inches in diameter. It was concluded that the blood was not changed by standing in the icebox and that probably a desensitization of the recipient had occurred following the first transfusion. This accounted for the absence of reaction when a donor was used a second time. Nine months after the transfusions had been given, the skin tests were repeated with the same results. As far as the recipient knows he has not been permanently sensitized to any food or other matter.

SUMMARY

1. Three cases are reported in which a supposed allergic reaction followed transfusion, when blood which had previously produced urticaria was used, no urticaria or allergic reactions developed. This probably represents a desensitization of the recipient by the first transfusion.

2. The causes of reactions to transfusions are reviewed.

3. Skin tests showed that the blood still produced urticaria after the blood had been stored twenty-four to forty-eight hours in the icebox. It was, therefore, concluded that storage of the blood in the icebox did not detoxify the blood.

4. When a blood transfusion is accompanied by an allergic reaction, it is always advisable to discontinue the transfusion and obtain blood from another fasting donor.

5. When, however, there are reactions following the use of every obtainable donor, it seems reasonably safe to give a very small transfusion, place the remaining blood in the icebox, then give the remainder of the blood in twenty-four hours after a desensitization of the recipient has occurred.

REFERENCES

1. Ramirez, M. A. Horse astha following blood transfusion. *J. A. M. A.*, 73: 984–986, 1919.
2. Carrington, G. L. and Lee, W. E. Fatal anaphylaxis following blood transfusion. *Ann. Surg.*, 78: 1–5, 1923.
3. Bottner, A. Anaphylaxis in blood transfusions, *Deutsche med. Wchnschr.*, 50: 599–600, 1924.
4. Gray, J. W. Therapeutic value of blood transfusions, *J. Med. Soc. New Jersey*, 25: 17–22, 1928.
5. Holder, H. G. and Diefenbach, W. E. Urticaria—its passive transmission by blood transfusion *Calif. & West. Med.*, 37: 387–388, 1932.
6. Tedstrom, M. K. Active transmission of urticaria by blood transfusion. *J. Allergy*, 5: 303–305, 1934.
7. Littlefield, J. B. Reactions in blood transfusions. *Southwest. Med.*, 18: 52–57, 1934.
8. Hancock, J. D. Allergic reactions following transfusion, *South. Surg.*, 5: 373–374, 1936.
9. Kordenat, R. A. and Smithies, F. Phenomena concerned with "reactions" following transfusion of blood. *J. A. M. A.*, 85: 1193–1200, 1925.
10. Polayes, S. H. and Lederer, M. Reactions to blood transfusions. *J. Lab. & Clin. Med.*, 17: 1029–1043, 1932.

LYMPHOSARCOMA OF THE INTESTINAL TRACT

REPORT OF A CASE IN WHICH THERE WAS AN APPARENT FIVE-YEAR CURE

HENRY H. RITTER, M.D. AND JAMES M. SHAFFER, M.D.*

Professor of Clinical Surgery, New York Post-Graduate Medical School, Columbia University

NEW YORK DAYTON, OHIO

LYMPHOSARCOMA of the intestinal tract is not a rare disease. Benjamin and Christopher[1] have recently added to the literature the 380th case of lymphosacroma of the small intestine. Since this report, Chont[2] has reported three additional cases with reference to their radiosensitivity.

The most common site for this neoplasm, according to Geschickter[3] is the ileum, followed by stomach and cecum in that order. Usually the growth is localized, starting in the submucosa and assuming either central ulceration with dilatation of the involved bowel or polypoid growths extending into the lumen. Early extension to the mesenteric nodes is common and there are often adhesions to surrounding abdominal organs. Later there is a generalized hematogenous spread. Ullman and Abeshouse[4] in summarizing their series of 126 cases of lymphosarcoma of the small and large intestine, point out that the tumor has an obscure etiology, occurs most frequently in white males, may occur at any age in life but most often in the first, third and fourth decades, commonly metastasizes and is often associated with intussusception. They also add that there is no characteristic clinical syndrome, which accounts for the difficulty in differentiating this condition from other intra-abdominal diseases. In most cases the predominant symptoms are those of an acute or chronic intestinal obstruction.

In the treatment of lymphosarcoma of the intestinal tract radical surgery of the involved segment and its mesentery, followed by *x*-ray, appears to offer the best results. While this treatment has appeared to prolong life in many instances, the prognosis for permanent arrest or cure must still be regarded as pessimistic. In the series reported by Ullman and Abeshouse,[4] there were eighty-five cases in which the follow-up was definite; of these only ten patients were alive and well five years or more after operation with no signs of recurrence. Sugarbaker and Craver[5] in analyzing 196 histologically proved cases of lymphosarcoma, of which eleven rose in the intestinal tract, report fourteen apparent five-year cures; none of these cures was in the intestinal group. The average survival period in which the stomach or small intestine was involved was only 6.6 months. These authors conclude that probably the single most important factor determining success or failure lay in some inherent quality of the disease which as yet it is impossible to evaluate. They could not predict on the basis of histology which of two clinically similar cases was apt suddenly to become generalized and which would remain localized for a considerable period.

Between 1928 and 1940 there were eleven cases of lymphosarcoma of the intestinal tract in which the patients were operated upon at the New York Post-Graduate Hospital. Of these, seven were males and four were females. The average age was fifty, the average duration of symptoms was nineteen months. The majority of these patients suffered from symptoms suggestive of chronic partial intestinal obstruction and this was the most frequent preoperative diagnosis. The

* Formerly Resident Surgeon, New York Post-Graduate Hospital.

tumor was present in the stomach in five cases, in the ileum in five and in the rectum in one. Careful follow-up was secured in only seven cases, of these only one patient lived longer than six months.

CASE REPORT

M. D., a white, married, elevated train motorman, aged fifty-five, entered New York Post-Graduate Hospital August 18, 1936, complaining of recurrent attacks of generalized, cramp-like, abdominal pain, accompanied by nausea and vomiting, during the preceding two and one-half years. He also suffered from progressively severe constipation necessitating daily catharsis. For the three weeks just before admission, he had vomited almost all food ingested and had lost twenty-one pounds in weight. There was no history of blood in the vomitus or stool.

Examination revealed a thin, dehydrated, cachectic individual. Visible active peristalsis was evident over the entire abdomen. No palpable masses were present. A hydrocele on the right side was noted. Fluids were given parenterally and operation performed the following day. At operation, intestinal obstruction was found due to a tumor of the upper ileum. The involved intestine, 10 cm. in length, was resected and a first-stage Mikulicz operation performed.

The postoperative course was uneventful and on the fifteenth day crushing clamps were applied. On the thirtieth day, reoperation was done for closure of a persistent sinus. At this operation, it appeared that a portion of the mesentery of the ileum was still involved. This mesentery and a 6 cm. section of intestine, including the anastomosis, was resected and an end-to-end anastomosis performed. The postoperative course was again uneventful and the patient was discharged on the twentieth postoperative day.

The pathological report disclosed a segment of ileum, 10 cm. in length, two-thirds of which was greatly dilated, thick-walled and contained an extensive, ulcerated fungating lesion. Tumor tissue was evident grossly through all the layers of the intestinal wall with numerous small nodules on the serosal surface. Microscopically, the basic pattern of the neoplasm was a fine connective tissue network upon which there were numerous layers of closely packed cells apparently arising in lymphoid tissue. The cells had round deep staining vesicular nuclei, with numerous mitotic division figures. Only chronic inflammatory changes were present in the mesentery. The diagnosis was malignant lymphoma of the ileum.

Following discharge from the hospital the patient returned to work. No *x*-ray therapy was given. He had to observe no dietary rules and has gained fifty pounds of weight. In July, 1940, he returned to the hospital for excision of his hydrocele.

When last seen on November 3, 1941, more than five years after the operation, the patient was in extremely good condition and free from all complaints. His belly wall was firm. He stated that he works every day and does not observe any dietary routine. At the time of his admission to the hospital he weighed 112 pounds and on this day he weighed 170 pounds.

SUMMARY

A case of lymphosarcoma of the small intestine is reported with an apparent five-year cure. Treatment consisted of radical surgical removal of the involved intestine and its mesentery.

BIBLIOGRAPHY

1. Benjamin, E. L. and Christopher, Frederick. Primary lymphosarcoma of the small intestine. Report of a case. *Am. J. Clin. Path.*, 10: 408, 1940.
2. Chont, L. K. Sarcomas of the small intestine and reference to their radiosensitivity. *Radiology*, 36: 86, 1941.
3. Geschickter, C. F. Tumors of the digestive tract. *Am. J. Cancer*, 25: 130, 1935.
4. Ullman, A. and Abeshouse, B. S. Lymphosarcomas of the small and large intestines. *Ann. Surg.*, 95: 878, 1932.
5. Sugarbaker, Everett D. and Craver, Lloyd F. Lymphosarcoma. *J. A. M. A.*, 115: 17, 1940.

Bookshelf Browsing

THE EVOLUTION OF BLOOD TRANSFUSION*

LEO M. ZIMMERMAN, M.D.
CHICAGO, ILLINOIS

BLOOD has always been associated with life and strength. Among primitive man's earliest experiences is the observation that life flows out of the body with the streaming blood. We are told that even the apes stuff leaves and moss into bleeding wounds to staunch the flow and preserve life. How natural, therefore, to attempt to restore life and youth and strength by the administration of healthy blood. The use of blood as a therapeutic agent is thus as old as medicine itself. Blood of man and diverse animals in various forms and combinations is found in all early pharmacopias. The ancient Egyptian princes are reported to have used baths of blood for resuscitation and recuperation. During the Roman Empire, it was customary for the patrician spectators to rush into the arenas to quaff the freshly flowing blood from the severed jugulars of the dying gladiators. History and mythology record ever recurring endeavors to cure disease, insanity and old age by replenishing the store of vital blood.

The actual expedient of transfusing blood could not be expected, however, to have had serious consideration before the discovery of the circulation by Harvey in 1616. It must be remembered that prior to this date, the Galenic concept prevailed, that blood was generated in the liver and that it moved back and forth in the vessels until used up. While it is true that several Renaissance writers speculated upon the possibilities of transferring blood from one person to another, actual experimentation necessarily followed Harvey and knowledge of the circulation.

The first co-ordinated and scientific studies on infusion and transfusion were done in England, probably because of the direct stimulation of Harvey's lectures. The astronomer and architect, Christopher Wren, first injected drugs into the veins of dogs in 1656, by means of bladders fastened to quills. He described his experiments to his friends, Wilkins, Robert Boyle and others, and they pursued them further. In the following year, the first human infusion was done in London, into a convicted criminal.

The first successful transfusion of blood from one animal to another was performed in 1665 in Oxford, and later, in London, by Richard Lower, anatomist and physician, who did "this experiment, hitherto looked upon to be of almost unsurmountable difficulty" by uniting the artery of one dog with the vein of another by means of quills or silver tubes. Reports of these achievements spread to other countries, and in the following year, the first human transfusion with animal blood was done in Paris by Jean Baptiste Denis. Denis' early experiences include, besides a number of successful transfusions, a classical observation of increasing sensitization with repeated animal blood injections, which resulted in successively severe reactions and culminated in the first transfusion death. The patient, a lunatic, had twice been given

* From the Division of Surgery, Northwestern University Medical School and the Departments of Surgery of Michael Reese and Chicago Memorial Hospitals, Chicago, Illinois. Read before the American Association of Railway Surgeons, Chicago, Illinois, September 17, 1940.

blood transfusions with temporary alleviation of his mania. Following the second transfusion, "his arm became hot, the pulse rose, sweat burst out over his forehead, he complained of pain in the kidneys and was sick at the stomach. The next day the urine was very dark, in fact black." A third transfusion, undertaken at the request of the patient's wife, resulted in death. Denis' enemies hastened to make capital of this misfortune. They conspired with the widow to bring action against the transfusor, charging him with murder. A prolonged legal battle ensued in which Denis was eventually exonerated on the murder charge but further transfusions were prohibited. Similar bans were applied in other countries, and the first chapter in the history of blood transfusion was closed.

Fig. 1. Earliest illustration of blood transfusion. Lamzweerde, 1672.

Except for an occasional sporadic attempt, the operation fell into complete desuetude for a period of almost 150 years. In this interim, however, some knowledge of coagulation and embolism was gained. Prevost and Dumas (1821) found that exsanguinated animals could be revived by the transfusion of blood, while the injection of serum or water was without effect. Blood from animals of another species was only temporarily efficacious. Defibrinated blood and blood which had been standing were found to be as beneficial as was fresh, whole blood.

The rediscovery of blood transfusion in the nineteenth century was again the contribution of an Englishman, the London physiologist and obstetrician, James Blundell (1790–1877). Appalled by his helplessness in the face of overwhelming hemorrhage, his mind turned again toward the direct expedient of returning blood to the exsanguinated organism. He subjected the question to careful scientific experimentation, and found that death from hemorrhage could be prevented by the transfusion of blood from animals of the same species, even after all signs of life had disappeared. Blood from animals of another species was unsuitable, since the resuscitation it effected was followed by death after several days. For human transfusion, therefore, he declared that only human blood was fit to be used. Direct transfusion required an operation upon the artery of the donor which was, in those days, a formidable procedure. Blundell, therefore, studied the effect of passing blood through a syringe. He found that it lost none of its life-giving properties by such handling. To obviate the necessity of cannulating the vein of the donor, he devised a three-way syringe similar to those in use today. This, and his later instruments, the "Impellor" and the "Gravitator" were the first of a long series of devices invented for the indirect transfusion of blood.

"With a mind rationally prepared to the best of my power by previous reflection and experiment," Blundell applied the results of his studies to the human body, and to him belongs the credit of performing the first transfusions with human blood. His first four attempts were desperate resorts in dying patients, and all failed. Convinced by his experiments, however, that he must succeed, he persevered, and was eventually able to resuscitate several women when death from postpartum hemorrhage seemed certain. He performed the operation eleven times, a number greater than that of any of his predecessors. He succeeded not only in bringing the operation of transfusion back into notice, but also in placing it upon a firm clinical basis with rational indications and a scientific background. Moreover, he introduced methods which find their expression in some of the common technics employed today.

Fig. 2. Early conceptions of animal and human blood transfusions. Mercklin, 1679.

Following the example of Blundell, a certain number of transfusions were done in England and on the continent. Its indication in the treatment of hemorrhage, particularly that following childbirth, had been established. It was an operation to be performed, however, only as a last resort. Donors were scarce. Phlebitis and sepsis, in both recipient and donor, were constant dangers. Reactions were frequent, and sometimes death occurred even when human blood was used. Furthermore,

technical difficulties were numerous, particularly those due to coagulation of the blood.

Fig. 3. Lamb blood transfusion. Purmann, 1684.

Knowledge toward the control of these difficulties was slowly acquired. Creite (1869) described the clumping of red blood corpuscles of man when placed in the sera of animals. Landois (1875) elaborated these experiments and found that serum of one species agglutinated and dissolved the corpuscles of other species. These investigations led more and more strongly to the conviction that the transfusion of foreign blood was dangerous, and that only human blood should be used. Defibrination of blood to prevent coagulation, and admixture with phosphate of soda to retard clotting were introduced.

Toward the end of the third quarter of the nineteenth century, the growing interest in blood transfusion culminated in a wave of exaggerated enthusiasm, in which the procedure was heralded as "ushering in a new era in medicine." With the increased popularity came a curious departure from the principles which had become firmly established during the years. Instead of limiting the operation to cases of anemia or acute hemorrhage, it was applied to a host of vague infectious and debilitating diseases, as well as to the "burnt, the uremic, the syphilitic and the mad." In spite of the frequently demonstrated dangers and disadvantages of heterologous transfusions, animal blood was again widely used. At the Congress of the German Surgical Society of 1874, there was a report of thirty-one sheep blood transfusions.

The efficacy of physiological salt solution infusions for the treatment of shock and acute anemia was demonstrated about this time (1875 to 1880). Its superiority over blood transfusion was unquestioned; donors were unnecessary, the technic was simple, the solution did not coagulate during its administration, and above all, it was safe. It rapidly supplanted blood transfusion and the latter operation was, therefore, once more virtually abandoned, this time not to be seriously taken up again until the beginning of the present century.

In this interval, modern surgery was born. Bacteriology became established as a science and asepsis came to surgery. With this, the danger of infection during transfusion fell away. The daughter science, immunology, was growing rapidly. In the year 1900, Landsteiner made the momentous discovery which subsequently won for him the Nobel Prize, that human blood contains isoagglutinins capable of agglutinating other human red blood corpuscles; and that human bloods were divided into three groups with reference to their agglutinating reactions. He recognized the significance of these findings in explaining the mysterious reactions which so often followed in the wake of blood transfusions. Decastello and Sturli, in 1902, added the fourth blood group. Hektoen (1907) urged that agglutination reactions be made the basis for the selection of donors for transfusion, and presented a simple method for determining the blood groups. In the following year, Ottenberg applied these important immunological discoveries in transfusion practice, and he subsequently showed that fatal reactions could be avoided by the use of compatibility and typing tests. The universal adoption of

these tests in the selection of blood donors has eliminated the last great danger in blood transfusion, and has made its modern widespread application possible.

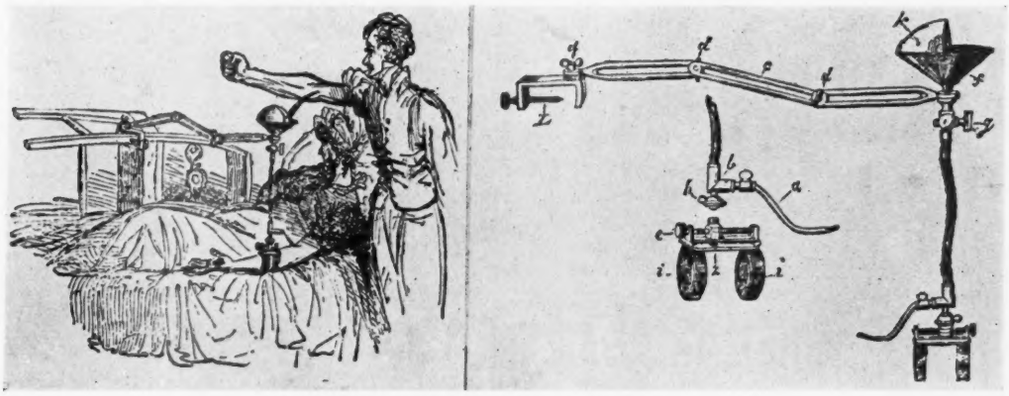


Fig. 4. Transfusion with Blundell's "Gravitator," 1628.

The remaining difficulties to be met were of a technical character, and these were largely overcome during the first quarter of the present century, with the development of several safe and simple methods of transfusion. At the beginning of this period, transfusions were done by the direct anastomosis of the vessels of donor and patient. Carrel perfected his method of blood vessel anastomosis in 1905, and for several years transfusions were done by uniting the artery of the donor with the vein of the recipient by suture. This necessitated a formidable operation and a delicacy of technic that limited its use to accomplished surgeons who were experienced in blood vessel surgery. Crile, in 1907, introduced his method of cuffing the artery back over a cannula and tying the vein over it. This greatly facilitated the operation and, together with its many modifications (Elsberg, Jeger, Soresi), was the preferred method for some time. To simplify the procedure further, recourse was again had to the simple cylindrical cannula (Brewer, Morel), similar to those used by Lower and Denis in the earliest transfusions.

All of these methods of direct transfusion, however, required the sacrifice of an artery of the donor. Moreover, it was impossible to measure the amount of blood transfused; there was danger to the donor in infectious cases, and mishaps due to the clotting of blood or the severing of the anastomosis by motion on the part of either patient or donor were distressingly frequent. Consequently, with the advent of simple and reliable indirect methods of transfusion, these direct ones were more and more neglected until, today, they are entirely obsolete.

It had been shown by Bordet and Gengou, in 1901, that clotting of blood could be delayed if it came into contact only with surfaces that had been coated with paraffine. Curtis and David made use of this principle in 1911, in an apparatus consisting of a paraffine-lined vessel having two outlets and connected with a syringe. Through one of these, blood was aspirated from the donor; through the other, it was injected into the patient. Two years later, Kimptom and Brown utilized the same idea in their paraffine-coated tube, which was subsequently modified by Percy, Vincent and Schlaefer, and which is still occasionally used today.

In the same year (1913) Lindeman revived a method described by Ziemssen in 1892, consisting of the use of multiple large syringes which were successively filled from a cannula in the vein of the donor and emptied through a second one in the vein of the recipient. Unger (1915) devised a four-way valve syringe attachment in which there were outlets to donor and recipient, and one to a reservoir containing

saline or citrate solution. There have been innumerable variations on this principle, and they continue to appear in an uninterrupted stream. Various types of cocks and valves have been devised to insure the success and safety of the transfusion. Practically all of the unmodified blood transfusions today are done by one or another of these methods.

Fig. 5. Transfusion with Aveling apparatus, 1863.

Two departures are sufficiently different in principle to warrant mention. In the tradition of the paraffined tube, attempts have been made to construct transfusion instruments of amber or plastic materials, in order to delay coagulation within the apparatus. Neubauer and Lampert[2] initiated this principle, and it has found considerable application, chiefly in Germany. Erb[3] and Buerkle-de la Camp[4] have devised instruments of amber and of "athrombit," a plastic substitute for amber. The other modification is the use of milking devices in which the blood is forced by various types of rollers, through rubber tubing, thus coming into contact with no other surface. The first of the instruments of this type was introduced by Beck,[5] in Germany. Subsequently, Henry and Jouvelet[6] in France, and DeBakey,[7] Baker,[8] and Pennell,[9] in this country have utilized this idea in various forms.

The greatest source of difficulty with these and the previously mentioned methods of transfusion was the clotting of blood within the apparatus. As has been stated, attempts had been made for the past one hundred years to render blood incoagulable by physical and chemical treatment. The transfusion of defibrinated blood was largely abandoned following the work of Koehler in 1877, who demonstrated that blood so treated contained an excess of fibrin ferments which exerted a hemolytic action on the cells of the recipient, and which were also potentially capable of initiating coagulative changes. It has since been pointed out that many of the reactions formerly attributed to defibrination were actually due to the use of incompatible bloods. Sporadic efforts are made, even today, to revive the use of defibrinated blood transfusions.

Landois (1892) suggested the use of hirudin to keep blood from clotting during transfusion, but it was difficult to obtain sufficiently pure and reliable preparations of the drug, and the range between effective and toxic doses was too narrow. Hustin, of Belgium, in 1914, reported his experiments on the use of sodium citrate and glucose to prevent coagulation. In the following year, Agote, of Buenos Aires, and Lewisohn in this country independently advocated the use of sodium citrate alone to prevent blood from clotting during transfusion. This discovery revolutionized the practice of blood transfusion. It became simple, safe and certain, and rapidly grew in popularity until its present widespread adoption was attained.

The one factor delaying the wider application of the citrate method of transfusion was the incidence of pyrogenic reactions. These were at first thought to be inherent in the method. Lewisohn and Rosenthal have since shown that chill reactions are always due to protein material derived from impurities in the apparatus or solutions. Careful elimination of such impurities enables the reduction of chill reactions to an incidence comparable with that of whole blood transfusions. Since then, there has been a wide swing back to citrate transfusions in civil and, particularly, in military practice.

NEWER DEVELOPMENTS IN BLOOD TRANSFUSION

Most of the recent innovations in blood transfusion are derivatives of the citrate method. Credit is due the Russian investigators for the energy, courage and ingenuity they have exhibited in their developments in the field of blood transfusion. The trend has been toward methods which make for wider applicability and obviate time loss in emergency situations. Preserved blood transfusions lend themselves admirably toward the achievement of these purposes, and much of the recent work has to do with the use of stored blood or blood constituents.

The transfusion of conserved blood is not new. Rous and Turner[10] showed in 1916 that blood could be preserved for prolonged periods without loss of viability of the erythrocytes. This method was applied during the World War by Robertson,[11] of the United States Army Medical Service, who used blood as old as twenty-six days. Preserved citrated blood was used by the Loyalist forces during the Spanish Civil War and was introduced into civil practice by the Russian workers. Its sudden popularity and wide adoption in this country and parts of Europe date from the initiation of the "blood bank" at the Cook County Hospital by Fantus and his coworkers.[12]

The advantages of preserved blood transfusions are obvious. Valuable time is saved in emergencies, seeking compatible donors. There is vast economy of time and effort, and more blood becomes available for transfusion. The relative safety and effectiveness of preserved blood is still being investigated. The consensus of opinion thus far is that blood is satisfactory for transfusion if not kept too long. Changes become demonstrable after five to ten days which render it unfit for transfusion.

Fig. 6. Capillary blood transfusion, Gesellius, 1868.

Cadaver Blood Transfusions. The use of cadaver blood for transfusion is also a Russian conception. These workers found that blood taken from fresh corpses retained its function and viability. Subsequently, in 1934, they reported that in cases of sudden death, the blood clotted promptly after its removal from the body, and later returned to the fluid state and remained incoagulable. This process of fibrinolysis rendered the addition of anticoagulants superfluous. The clinical use of

cadaver blood for human transfusions was introduced by Yudin[13] who, in a series of publications, has reported satisfactory results in a large number of cases.

Whether because of fear or sentiment, acceptance of cadaver blood transfusion has been extremely reluctant in countries outside of Russia. It is more than possible, however, that in times of war when sentiment, perforce, goes by the board, when the needs for donor blood may reach staggering proportions, and when there is no lack of corpses due to sudden violence, that the use of cadaver blood for transfusion may be generally adopted.

Placental Blood Transfusions. The expedient of using placental blood for transfusion appears to have occurred independently to a number of workers in different countries. Perhaps the earliest reference to placental blood transfusion is by Ascoli and Vercesi from Italy, in 1934. The Russian investigators published their first series of 114 placental blood transfusions in 1936. Goodall and his collaborators[14] advocated the use of placental blood on this continent in 1938, since which time there has been a moderate display of interest in this source of blood for transfusion.

Serum and Plasma Transfusions. Serum or plasma has been used sporadically over a long period of time, as a substitute for whole blood. Recently Strumia and his coworkers[15] and Levinson, Neuwelt and Necheles[16] have convincingly demonstrated the efficacy of these blood constituents, particularly in the treatment of shock. They possess two outstanding advantages: They can, apparently, be preserved for indefinite periods without deterioration, and they may be used without preliminary typing or compatibility tests. They may thus be kept in operating or delivery rooms, ready for immediate injection when emergency need arises.

CONCLUSIONS

Blood transfusion has had a long and interesting history. The idea of restoring blood to the depleted and exsanguinated organism appealed quite naturally, long before the risks and difficulties attendant upon blood transfusion were known. As a result, there have been alternate periods of enthusiastic acclaim and of complete neglect. Pasteur and Lister pointed the way toward the conquest of infection, the first great danger. Reactions from incompatible bloods were eliminated by the application of Landsteiner's discovery of the isoagglutinins. The modern era in blood transfusion has taught technical methods that permit the safe, simple and certain transference of blood from donor to patient.

REFERENCES

1. For bibliography the reader is referred to an earlier publication, Zimmerman, L. M. and Howell, K. M. History of blood transfusion. *Ann. Med. Hist.*, 4: 415–433, 1932.
2. Neubauer, O. and Lampert, H. Ein neuer Bluttransfusions-apparat. *Münchcn. med. Wchnschr.*, 77: 582–586, 1930.
3. Erb, K. Bernstein-Bluttransfusionsapparat mit neuem Prinzip der Mechanik bei der Blutuebertragung. *Arch. f. klin. Chir.*, 186: 212–215, 1936.
4. Buerkle-de-la Camp, H. *Zentralbl. f. Chir.*, 58: 854–856, 1931.
5. Beck, A. Die Methodik der Bluttransfusion und die Vermeidung ihrer Gefahren. *Ergebn. d. inn. Med. u. Kinderh.*, 30: 150–220, 1926.
6. Henry and Jouvelet, Appareil à transfusion du sang. *Presse méd.*, 42: 828–829, 1934.
7. De Bakey, M. A simple continuous-flow blood transfusion instrument. *New Orleans M. & S. J.*, 87: 386–389, 1934.
8. Cashman, B. Z. and Baker, M. H. Massive blood transfusions during abdominal operations. *Am. J. Obst. & Gynec.*, 31: 240–252, 1936.
9. Pennell, S. A new type of blood transfusion apparatus. *Am. J. Surg.*, 45: 354–356, 1939.
10. Rous, P. and Turner, J. R. The preservation of living red blood cells in vitro. *J. Exper. Med.*, 23: 219–237, 1916.
11. Robertson, O. H. Transfusion of preserved red blood cells. *Brit. M. J.*, 1: 691–695, 1918.
12. Fantus, B. Blood preservation. *J. A. M. A.*, 109: 128–131, 1937.
13. Yudin, S. S. Transfusion of cadaver blood. *J. A. M. A.*, 106: 997–999, 1936.
14. Goodall, J. R., Anderson, F. O., Altimas, G. T. and McPhail, F. L. An inexhaustible source of blood for transfusion and its preservation. *Surg., Gynec. & Obst.*, 66: 176–178, 1938.
15. Strumia, M. M., Wagner, J. A. and Monaghan, J. F. The use of citrated plasma in the treatment of secondary shock. *J. A. M. A.*, 114: 1337–1341, 1940.
16. Levinson, S. O., Neuwelt, F. and Necheles, H. Human serum as a blood substitute. *J. A. M. A.*, 114: 455–461, 1940.

AUTHOR INDEX TO VOLUME LV

Al Akl, F. M., 520
Allen, Frederick M., 451
Allen, Philip D., 496
Ansbro, F. Paul, 504
Austen, George, Jr., 509

Bachhuber, Carl A., 487
Baker, Chas. P., 386
Baker, Morton, 113
Batten, Douglass H., 83
Beck, Wm. C., 113
Bergmann, Ernst, 548
Berk, J. Edward, 96
Bisgard, J. Dewey, 386
Blaisdell, Jack, 177
Brannon, L. J., 169
Brav, Ernest A., 57
Brenner, F. T., 181
Brown, A. Lincoln, 173
Bulfamonte, Jos. C., 175
Bunch, George H., 169
Burnside, A. F., 169

Carmichael, F. A., Jr., 583
Carter, Robert E., 143
Cassels, William H., 410
Cazan, George M., 317
Chilko, Alexander J., 75
Chodoff, Richard J., 606
Cohn, Isidore, 210
Cole, Warren H., 410
Crile, George, 441

DeCourcy, Joseph L., 562
Diamond, J. C., 121
Dobbie, Robert P., 339
Donaldson, J. K., 537

Flynn, J. Edward, 467
Foncannon, Frank, 600
Friedman, H. Harold, 88

Gnassi, A. M., 163
Greenfield, Irving, 590
Gross, Sidney W., 575
Gurd, Fraser B., 189
Gutierrez, Robert, 28

Hamlin, Edward, Jr., 274
Harrell, Wm. B., Jr., 537
Helfrich, Loring S., 410
Helwig, F. C., 583
Heyd, Chas. Gordon, 18
Horton, William S. S., 597
Horwich, Ivor David, 166
Horwitz, Thomas, 550

Ingham, John L., 492

Jones, Robert A., 326

Kaplan, David, 131
Kennedy, Robert H., 309
Kooistra, Henry P., 3
Koucky, John D., 113
Krepela, Miles C., 49

LaFerte, A. D., 228
Lederer, Max, 88
Lichtenstein, Manuel E., 157
Long, Carroll H., 71

Macdonald, Dean, 148
MacGregor, D. A., 602
Mackby, Maxwell J., 527
Maliniac, Jacques W., 123
Marble, Henry C., 274
Mathewson, Carleton, Jr., 295
Mayfield, Frank H., 317
McIver, Monroe A., 180
McLaughlin, Charles W., Jr., 588
McNealy, R. W., 157
Mickal, Abe, 71
Miller, Harry, 228
Murray, Clay Ray, 262

O'Brien, Gerald R., 102
Ochsner, Alton, 71
O'Shea, Maurice Culmer, 578
Otken, Luther B., 160

Palmer, E. Payne, 397
Patterson, D. C., 184
Pico, L. J., 504
Price, H. P., 163

Quastler, Henry, 75
Quigley, T. B., 250

Rebbeck, E. W., 476
Renie, Robert O., 126
Rigdon, R. H., 553
Ritter, Henry H., 611
Roesch, C. Burling, 520
Ross, Donald E., 37
Rousuck, A. Ashley, 177
Rubin, Leonard R., 102
Rusbridge, Harold W., 374
Ryerson, Scott, 339

Sadowsky, A., 544
Sanderlin, Joe H., 537
Scott, Michael, 534
Shaffer, James M., 611
Shoor, Mervyn, 173
Simon, Max Michael, 566
Singer, Alexander, 520
Slocum, M. A., 183
Smith, Caleb H., 141
Snyder, Clarence H., 67
Stegeman, Wilson, 156
Stockhammer, Stanley F., 49
Strenger, George, 594
Stump, John P., 49

Thorek, Phil, 118
Thorndike, Augustus, Jr., 250
Thorstad, M. Jordan, 44
Timerman, Harris J., 138
Turell, Robert, 516

Vale, C. Fremont, 500

Watkins, Arthur L., 274
Weil, Grover C., 374
Wheeler, J. H., 583
Whitaker, Darrell W., 374
Willauer, George, 606
Winfield, James M., 228
Wolf, George D., 152

Young, Robert E. S., 607

Zimmerman, Leo M., 613

SUBJECT INDEX TO VOLUME LV

(Bo. B.) = Bookshelf Browsing; (E.) = Editorial

Abdomen
  neuralgia of, 492
  surgical emergencies of, 397
Abscesses, intra-abdominal, localization of by roentgenography, 113
Accuracy, descriptive, at operation, 180
Adenocarcinoma of rectum and tumor of jejunum, 163
Adrenal apoplexy, 44
Anesthesia
  continuous, spinal, 504
  digital nerve block, and gangrene of finger, 588
  in thyrotoxicosis, pentothal sodium for, 71
  regional, for ligation of saphenous vein, 141
Ankle joint, arthrodesis of, 550
Apoplexy, adrenal, 44
Appendectomy
  and ileal obstruction, 157
  intestinal fistula after, 566
Appendicitis
  acute, in children, 496
  postpartum, 138
Arthritis, pathogenesis of, in adult rabbit, 553
Arthrodesis of ankle joint, transfibular approach in, 550

Back, lower, pain in, 57
Bladder, suprapubic drainage of, 509
Block, subarachnoid, analysis of, 317
Blood
  autotransfused, irradiation of, in postabortional sepsis, 476
  transfusion, allergic reaction in, 607
    evolution of (Bo.B.), 613
Body
  foreign, intrapleural, removal of, 606
    migrating, 600
Bones, long, reduction in fractures of, 49
Book Review:
  Hugh Owen Thomas, 184
Breast, cancer of, metastases in, 75
Breech forceps, 181
Bruit, cephalic, 527

Cancer
  natural selection applied to (E.), 441
  of breast, metastases in, 75
Carcinoma
  rectal, metastasis in, 590
  squamous cell epidermoid, involving the os calcis, 166
Care, convalescent, of patients with fractures, 309
Cast, hanging, for fractures of humerus, 228
Cephalic bruit, 527
Child, newborn, ovarian cyst in, 175
Children, acute appendicitis in, 496
Cholecystectomy in male, mortality of, 487
Choledocholithiasis, 96
Chordoma, cranial, 583
Colostomies, aid in management of, 183
Compression of spinal cord in Paget's disease of vertebrae, 575
Control of postoperative infection, 562
Cord
  spinal, compression of, 575
    injuries to, 317
Cortical extract for shock, 410
Cosmetic surgery, economic considerations of, 126
Cotton, spool, for sutures, 118
Cranium, chordoma of, 583
Cyst, ovarian, in newborn child, 175

Defect, traumatic, of finger tip, 326
Diagnosis of low back pain, 57
Disease, Paget's, compression of, spinal cord in, 575
Dissemination, metastatic, and melanoblastoma, 88
Division of renal isthmus in horseshoe kidney, 28
Drainage, trocar, of bladder, 509

Effect, therapeutic, of sulfathiazole, 374
Elbow, fractures of, 210
Emergencies, surgical, of abdomen, 397
Evaluation of hanging cast, 228
Evolution of blood transfusion (Bo.B.), 613
Excision, treatment of fractured patella by, 339
Experiences with spool cotton for sutures, 118
Extract, cortical, for shock, 410

Face, infections of, 102
Finger
  postoperative gangrene of, 588
  tip, traumatic defect of, 326
Fishbone, perforation of intestine with, 169
Fistula, external, intestinal, 566
Foot, reduction in size of, 548
Forceps, for breech position, 181
Foreign body
  migrating, 600
  removal of, with thoracoscope, 606
Fractures
  care of patients with, 309
  of elbow, 210
  of humerus treated with hanging cast, 228
  of long bones, reduction in, 49
  spiral and oblique, of tibia, 295

Gallbladder, sclerosis of, 148
Gangrene, postoperative, of finger, 588
Gastrointestinal suction-irrigation device, 177
Grafting, implant, skin, 597
Growth, partial giant, 548
Gunshot wounds, treatment of (E.), 189

Hand, infections of, 467
Hanging cast, evaluation of, 228
Heart, stab wound of, 143
Hemorrhage
  rectal, from capillary oozing, 602
  spontaneous, into rectus abdominis muscle, 594
Hormones, ovarian, for postoperative tetany, 131
Humerus, fracture of, treated with hanging cast, 228
Hydrocele, treatment and cure of, 121
Hygroma, subdural, and stupor, 534
Hypoxia, the hazard of operating room, 83

Ileum, obstruction of, and appendectomy, 157
Implant skin grafting, 597
Incision, abdominal, suspension of uterus without, 537

Infections
deep, fascial, of hand, 467
of face and neck after oral pathology, 102
postoperative, 562
Injection of staphylococci in adult rabbit, 553
Injuries
spinal cord, 317
to acromioclavicular joint, 250
to menisci of knee joint, 262
Intestine
fistula of, after appendectomy, 566
lymphosarcoma of tract of, 611
perforation of, with fishbone, 169
Investigations, clinical and anatomical, in infections of hand, 467
Isthmus, renal, division of, in horseshoe kidney, 28

Jejunum, chromargentaffine tumor of, 163
Joint
acromioclavicular, injuries to, 250
ankle, arthrodesis of, 550
knee, injuries to menisci of, 262
synovioma of, 67

Kidney
horseshoe, division of renal isthmus in, 28
incarcerated pelvic, 156
Knee joint, synovioma of, 67

Lest we forget (E.), 1
Ligation, high, regional anesthesia for, 141
Lithium salicylate, quinine hydrochloride and urethane for hydrocele, 121
Lupus of skin, surgical treatment of, 123
Lymphosarcoma of intestinal tract, 611

Male, cholecystectomy in, 487
Management of colostomies, aid in, 183
Median nerves, regeneration in, 274
Melanoblastoma and metastatic dissemination, 88
Menisci of knee joint, injuries to, 262
Metastasis
delayed, in cancer of breast, 75
of rectal carcinoma, 590
Military surgery, refrigeration in, 451
Montreal General Hospital, résumé of clinics at, 427
Morals and manners, medical (E.), 1
Mortality
and morbidity in surgery of thyroid, 18
in cholecystectomy in male, 487
Muscle, rectus abdominis, hemorrhage into, 594

Neck, infections of, 102
Nerves
abdominal, and neuralgia, 492
ulnar, median and radial, regeneration in, 274
Neuralgia, abdominal, in relation to abdominal nerves, 492
Nose, paraffinoma of, 152

Obstruction, ileal, following appendectomy, 157
Oozing, capillary, and rectal hemorrhage, 602
Os calcis, epidermoid carcinoma involving, 166
Ovary
cyst of, in newborn child, 175
melanotic sarcoma of, 160

Paget's disease, compression of spinal cord in, 575
Pain, low back, of orthopedic origin, 57
Paraffinoma of nose, 152
Patella, fractured, treatment by excision of, 339
Pathogenesis of arthritis after injection of staphylococci, 553
Patients with fractures, care of, 309
Pelvis, kidney incarcerated in, 156
Pentothal sodium for anesthesia in thyrotoxicosis, 71
Perforation, intestinal, from ingested fishbone, 169
Peritoneoscope and special needle for suspension of uterus, 537
Peritonitis, pneumococcic, 578
Pilonidal sinuses, 3
Postpartum appendicitis, 138
Principle of natural selection applied to genesis of cancer (E.), 441
Proctology in office practice, 516

Radial nerves, regeneration in, 274
Reaction, allergic, after blood transfusion, 607
Rectum
adenocarcinoma of, and tumor of jejunum, 163
hemorrhage of, from capillary oozing, 602
metastasis of carcinoma in, 590
Reduction
in fractures of long bones, 49
in size of foot, 548
Refrigeration, pelvic and abdominal, 451
Resection, gastric, for ulcer, 500
Résumés of clinics at Montreal General and Royal Victoria Hospitals, 427
Roentgenography for localization of intra-abdominal abscesses, 113
Royal Victoria Hospital, résumés of clinics at, 427
Rupture, uterine, diagnosis of, 544

Sarcoma, melanotic, of ovary, 160
Sclerosis, experimental, of gallbladder, 148
Selection, natural, principle of, in cancer (E.), 441
Sepsis, postabortional, autotransfused blood in, 476
Shock, treatment of, with cortical extract, 410
Sinuses, pilonidal, 3
Skin
grafting, implant, 597
lupus of, 123
Spine, injuries to cord of, 317
Spool cotton for sutures, 118
Stab wound of heart, 143
Staphylococci, injection of, in rabbit, 553
Stupor, prolonged, caused by subdural hygroma, 534
Sulfathiazole, local therapeutic effect of, 374
Suprapubic trocar drainage of bladder, 509
Surgery
of thyroid, mortality and morbidity in, 18
plastic, economic considerations of, 126
reduced temperatures in, 451
vascular, 520
Suspension of uterus without abdominal incision, 537
Sutures, spool cotton for, 118
Synovioma, malignant, of knee joint, 67

Table, operating, accuracy at, 180
Temperatures, reduced, in surgery, 451
Tetany, postoperative, parathyroid, treatment of, 131
Thoracoscope, for removal of foreign body, 606
Thyroid, surgery of, mortality in, 18
Thyroidectomy, 37
Thyrotoxicosis, pentothal sodium for anesthesia in, 71
Tibia, treatment for, fractures of, 295

Tract, intestinal, lymphosarcoma of, 611
Transfusion
  blood, allergic reaction in, 607
    evolution of (Bo.B.), 613
Treatment
  conservative, for injuries to acromioclavicular joint, 250
  of fractured patella by excision, 339
  of fractures of tibia, 295
  of fresh traumatic wounds, 386
  of injuries to knee joint, 262
  of shock with cortical extract, 410
  surgical, of lupus of skin, 123
Trephine and drainage for hygroma, 534
Tumor, chromargentaffine, of jejunum, 163
Twin-injection of hydrocele, 121

Ulcer, gastric resection for, 500
Ulnar nerves, regeneration in, 274
Ultraviolet irradiation, of autotransfused blood in post-abortional sepsis, 476
Uterus
  rupture of, 544
  suspension of, 537

Vascular surgery, peripheral, 520
Vein, saphenous, high ligation of, 141

Wound, stab, of heart, 143
Wounds
  gunshot (E.), 189
  traumatic, treatment of, 386

The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.
49 WEST 45TH STREET, NEW YORK, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., NEW YORK

EDITORIAL BOARD

FRED H. ALBEE, *N.Y.*; CARL BECK, *Chicago*; CLAUDE S. BECK, *Clev.*; GEO. R. BRIGHTON, *N.Y.*; MEREDITH F. CAMPBELL, *N.Y.*; JAMES T. CASE, *Chicago*; ISIDORE COHN, *N.O.*; BRADLEY L. COLEY, *N.Y.*; FREDERICK A. COLLER, *Ann Arbor*; PAUL C. COLONNA, *Okla. City*; GEORGE W. CRILE, *Clev.*; ELLIOTT C. CUTLER, *Boston*; CHARLES A. ELSBERG, *N.Y.*; HERBERT C. FETT, *Brooklyn*, C. R. G. FORRESTER, *Chicago*; JOHN H. GIBBON, *Phila.*; EMIL GOETSCH, *Brooklyn*; CHARLES A. GORDON, *Brooklyn*; DONALD GUTHRIE, *Sayre, Pa.*; A. E. HERTZLER, *Kansas City*; LOUIS J. HIRSCHMAN, *Detroit*; J. M. HITZROT, *N.Y.*; FREDERICK C. HOLDEN, *N.Y.*; EMILE F. HOLMAN, *San Francisco*; J. A. HYAMS, *N.Y.*; JOHN E. JENNINGS, *Brooklyn*; W. L. KELLER, *Washington*; HOWARD A. KELLY, *Baltimore*; T. J. KIRWIN, *N.Y.*; ARTHUR KRIDA, *N.Y.*; A. V. S. LAMBERT, *N.Y.*; MAURICE LENZ, *N.Y.*; H. H. LYLE, *N.Y.*; JEROME M. LYNCH, *N.Y.*; URBAN MAES, *N.O.*; HARRISON S. MARTLAND, *Newark, N.J.*; RUDOLPH MATAS, *N.O.*; ROY D. MCCLURE, *Detroit*; H. C. NAFFZIGER, *San Francisco*; EMIL NOVAK, *Balt.*; CLARENCE R. O'CROWLEY, *Newark, N.J.*; LOUIS E. PHANEUF, *Boston*; EUGENE H. POOL, *N.Y.*; JAMES T. PRIESTLEY, *Rochester, Minn.*; DOUGLAS QUICK, *N.Y.*; N. P. RATHBUN, *Brooklyn*; HUBERT A. ROYSTER, *Raleigh*; HENRY S. RUTH, *Phila.*; M. G. SEELIG, *St. Louis*; J. BENTLEY SQUIER, *N.Y.*; H. J. STANDER, *N.Y.*; GRANT E. WARD, *Baltimore*; J. H. WOOLSEY, *San Francisco*.

NEW SERIES, VOLUME LV

JANUARY TO MARCH

1942

THE AMERICAN JOURNAL OF SURGERY, INC., PUBLISHERS
NEW YORK MCMXLII

COPYRIGHT, 1942
BY THE AMERICAN JOURNAL OF SURGERY, INC.
All Rights Reserved

Printed in the United States of America

CONTENTS OF NEW SERIES, VOLUME LV

ORIGINAL ARTICLES

Pilonidal Sinuses. Review of the Literature and Report of Three Hundred Fifty Cases	*Henry P. Kooistra*	3
Mortality and Morbidity in Surgery of the Thyroid	*Chas. Gordon Heyd*	18
Operative Technic for Division of Renal Isthmus in Horseshoe Kidney	*Robert Gutierrez*	28
Thyroidectomy	*Donald E. Ross*	37
Adrenal Apoplexy	*M. Jordan Thorstad*	44
Maintaining Reduction in Oblique Fractures of Long Bones	*John P. Stump*, *Miles C. Krepela*, *Stanley F. Stockhammer*	49
Diagnosis of Low Back Pain of Orthopedic Origin. An Analysis of Sixty-two Cases	*Ernest A. Brav*	57
Malignant Synovioma of the Knee Joint	*Clarence H. Snyder*	67
Use of Pentothal Sodium for the Induction of Anesthesia in Thyrotoxicosis	*Carroll H. Long*, *Abe Mickal*, *Alton Ochsner*	71
Delayed Metastases in Cancer of the Breast	*Alexander J. Chilko*, *Henry Quastler*	75
Hypoxia—The Hazard of the Operating Room	*Douglass H. Batten*	83
Melanoblastoma. With Special Reference to Metastatic Dissemination	*H. Harold Friedman*, *Max Lederer*	88
Choledocholithiasis	*J. Edward Berk*	96
One Hundred One Cases of Infections of the Face and Neck Following Oral Pathology	*Gerald R. O'Brien*, *Leonard R. Rubin*	102
Diagnosis and Localization of Intra-abdominal Abscesses by Roentgenological Methods	*Wm. C. Beck*, *John D. Koucky*, *Morton Baker*	113
Experiences with Spool Cotton as a Suture Material	*Phil Thorek*	118
Treatment and Cure of Seventy-six Cases of Hydrocele by One Twin-Injection of Lithium Salicylate and Quinine Hydrochloride and Urethane	*J. C. Diamond*	121
Surgical Treatment of Lupus of the Skin. Case Report	*Jacques W. Maliniac*	123
Economic Considerations of Cosmetic Surgery	*Robert O. Renie*	126
Treatment of Postoperative Parathyroid Tetany with Ovarian Hormones. Report of Two Cases	*David Kaplan*	131
Postpartum Appendicitis. Report of Two Cases	*Harris J. Timerman*	138
Regional Anesthesia for High Ligation of the Internal Saphenous Vein	*Caleb H. Smith*	141
Stab Wound of the Heart. Report of Two Cases in Which Suturing Was Successful	*Robert E. Carter*	143
Experimental Sclerosis of the Gallbladder. Preliminary Report	*Dean Macdonald*	148
Paraffinoma of the Nose. Case Report	*George D. Wolf*	152

Incarcerated Pelvic Kidney Exhibiting Unusual Features	*Wilson Stegeman*	156
Acute Mechanical Ileal Obstruction Following Appendectomy	*R. W. McNealy*, *Manuel E. Lichtenstein*	157
Primary Melanotic Sarcoma of Ovary	*Luther B. Otken*	160
Adenocarcinoma of the Rectum and Chromargentaffine Tumor of the Jejunum	*A. M. Gnassi*, *H. P. Price*	163
Infiltrating Squamous Cell Epidermoid Carcinoma Involving the Os Calcis	*Ivor David Horwich*	166
Intestinal Perforation from Ingested Fishbone	*George H. Bunch*, *A. F. Burnside*, *L. J. Brannon*	169
Struma Ovarii. Case Report	*A. Lincoln Brown*, *Mervyn Shoor*	173
Large Ovarian Cyst in Newborn Child	*Jos. C. Bulfamonte*	175
New Gastrointestinal Suction-Irrigation Device	*Jack Blaisdell*, *A. Ashley Rousuck*	177
Greater Descriptive Accuracy at the Operating Table	*Monroe A. McIver*	180
New Breech Forceps	*F. T. Brenner*	181
Useful Aid in the Management of Colostomies	*M. A. Slocum*	183
Hugh Owen Thomas	*D. C. Patterson*	184
Fractures of the Elbow	*Isidore Cohn*	210
Evaluation of the "Hanging Cast" as a Method of Treating Fractures of the Humerus	*James M. Winfield*, *Harry Miller*, *A. D. LaFerte*	228
Injuries to the Acromioclavicular Joint. A Plea for Conservative Treatment	*Augustus Thorndike, Jr.*, *T. B. Quigley*	250
Complicating Factors in the Treatment of Injuries to the Menisci of the Knee Joint	*Clay Ray Murray*	262
Regeneration in the Ulnar, Median and Radial Nerves	*Henry C. Marble*, *Edward Hamlin, Jr.*, *Arthur L. Watkins*	274
Spiral and Oblique Fractures of the Tibia. A Method of Treatment	*Carleton Mathewson, Jr.*	295
Convalescent Care of Patients with Fractures	*Robert H. Kennedy*	309
Spinal Cord Injuries. Analysis of Six Cases Showing Subarachnoid Block	*Frank H. Mayfield*, *George M. Cazan*	317
Method for Closing a Traumatic Defect of a Finger Tip	*Robert A. Jones*	326
Treatment of Fractured Patella by Excision	*Robert P. Dobbie*, *Scott Ryerson*	339
Local Therapeutic Effect of Sulfathiazole	*Grover C. Weil*, *Darrell W. Whitaker*, *Harold W. Rusbridge*	374
Treatment of Fresh Traumatic Wounds	*J. Dewey Bisgard*, *Chas. P. Baker*	386
Traumatic Abdominal Surgical Emergencies	*E. Payne Palmer*	397
Cortical Extract in the Treatment of Shock. Preliminary Report	*Loring S. Helfrich*, *William H. Cassels*, *Warren H. Cole*	410

Résumés of Clinics at Montreal General and Royal Victoria Hospitals		427
Reduced Temperatures in Surgery. III. Experiments on Pelvic and Abdominal Refrigeration with Especial Reference to Traumatic and Military Surgery	*Frederick M. Allen*	451
Clinical and Anatomical Investigations of Deep Fascial Space Infections of the Hand	*J. Edward Flynn*	467
Ultraviolet Irradiation of Autotransfused Blood in the Treatment of Postabortional Sepsis	*E. W. Rebbeck*	476
Mortality of Cholecystectomy in the Male	*Carl A. Bachhuber*	487
Abdominal Neuralgia in Relation to the Superficial Abdominal Nerves	*John L. Ingham*	492
Acute Appendicitis in Children	*Philip D. Allen*	495
Gastric Resection for Ulcer. Experience in Forty-four Cases	*C. Fremont Vale*	500
Continuous Spinal Anesthesia. Report of One Hundred Cases in Which This Method Was Employed	*F. Paul Ansbro*, *L. J. Pico*	504
Suprapubic Trocar Drainage of the Bladder	*George Austen, Jr.*	509
Proctology in General Office Practice	*Robert Turell*	516
Peripheral Vascular Surgery. Lessons from Six Years' Experience	*F. M. Al Alk*, *Alexander Singer*, *C. Burling Roesch*	520
Cephalic Bruit. A Review of the Literature and a Report of Six Cases	*Maxwell J. Mackby*	527
Prolonged Stupor Produced by Subdural Hygroma. Relief by Trephine and Drainage	*Michael Scott*	534
Method of Suspending the Uterus without Open Abdominal Incision. Use of the Peritoneoscope and a Special Needle	*J. K. Donaldson*, *Joe H. Sanderlin*, *Wm. B. Harrell, Jr.*	537
Diagnosis of Uterine Rupture	*A. Sadowsky*	544
Partial Giant Growth. Operative Reduction in Size of a Foot	*Ernst Bergmann*	548
Use of the Transfibular Approach in Arthrodesis of the Ankle Joint	*Thomas Horwitz*	550
Pathogenesis of Arthritis Following the Intravenous Injection of Staphylococci in the Adult Rabbit	*R. H. Rigdon*	553
Postoperative Infection. Its Control by Surgical Technic	*Joseph L. De Courcy*	562
Persistent External Intestinal Fistula. Review of the Literature with Report of an Unusual Case Following Appendectomy	*Max Michael Simon*	566
Compression of the Spinal Cord in Paget's Disease of the Vertebrae	*Sidney W. Gross*	575
Pneumococcic Peritonitis	*Maurice Culmer O'Shea*	578
Cranial Chordoma. Report of a Case in Which Surgical Intervention Was Successful	*F. A. Carmichael, Jr.*, *F. C. Helwig*, *J. H. Wheeler*	583
Postoperative Gangrene of the Finger Following Digital Nerve Block Anesthesia. Report of a Case.	*Charles W. McLaughlin, Jr.*	588

Unusual Metastasis of Rectal Carcinoma. Case Report	*Irving Greenfield*	590
Spontaneous Hemorrhage into the Rectus Abdominis Muscle Simulating Acute Intra-abdominal Conditions	*George Strenger*	594
Implant Skin Grafting. Case Report	*William S. S. Horton*	597
Migrating Foreign Body	*Frank Foncannon*	600
Massive Fatal Rectal Hemorrhage from Capillary Oozing. Case Report	*D. A. MacGregor*	602
Removal of Intrapleural Foreign Body under Thoracoscopic Guidance. Case Report	*George Willauer*, *Richard J. Chodoff*	606
Allergic Reaction Following Blood Transfusion. Apparent Desensitization of Recipient	*Robert E. S. Young*	607
Lymphosarcoma of the Intestinal Tract. Report of a Case in Which There Was an Apparent Five-year Cure	*Henry H. Ritter*, *James M. Shaffer*	611
Evolution of Blood Transfusion	*Leo M. Zimmerman*	613

HOW SIMPLE is the infusion technique in your hospital?

No need to remind you of the sterility hazards in any involved procedure for intravenous injection. The simpler your apparatus, the safer in use.

That is why hospital staff and doctor alike will appreciate Saftiflasks — Cutter solutions that are safe-tested by a biological laboratory and safer in use because of the flask's complete simplicity.

Tested, Safe-Proven Solutions

Subjected to such rigid checks as only a biological laboratory is equipped to carry on, each lot of Cutter Solutions is *proven safe before administration.* Rabbits, not your patients, chance reactions!

CUTTER Laboratories

BERKELEY · CHICAGO
NEW YORK

Seattle · Los Angeles · New Orleans · Ft. Worth · San Antonio · Denver

One of America's oldest biological laboratories

UNITED DRUG COMPANY
AND
YOUR REXALL DRUGGIST
YOUR PARTNERS IN HEALTH SERVICE

Rexall DRUGS

U. D. Products are available wherever you see this sign.

VITAMINS ESSENTIAL TO YOUR PATIENTS' HEALTH IN SMALLER, EASIER-TO-TAKE DOSES

Puretest High Potency Cod Liver Oil contains more than 1800 units of Vitamin A and more than 150 units of Vitamin D to each gram. It is almost twice as potent as the minimum U.S.P. standard of Cod Liver Oil. It thus enables you to prescribe a smaller dose for the desired vitamin intake than is usually required. Puretest Cod Liver Oil has been chosen as an addition to the diet of the Dionne Quintuplets.

Puretest Plenamins — A, B, D, C, E and G (B_2) with Liver Concentrate and Iron Sulfate are economically packaged in amber and black capsules in boxes of 72 and 144 to the box. One amber and one black capsule supply the following essential Vitamins:

One Amber Capsule Contains:

Vitamin A (from Fish Liver Oils)	15,000 Units U.S.P.X1
Vitamin D (Synthetic)	1,000 Units U.S.P.
Vitamin E	Wheat Germ Oil ½ min.

One Black Capsule Contains:

Vitamin B_1 (Thiamine Hydrochloride 1 mg.)	333 Units U.S.P.
Vitamin C (Ascorbic Acid 25 mg.)	500 Units U.S.P.
Vitamin G (B_2) Riboflavin	100 Micrograms
Liver Concentrate	2 Grains
Ferrous Sulfate (U.S.P.)	1 Grain

Only through your Rexall Druggist (Liggett and Owl Stores are also Rexall Stores) can you obtain Puretest and U. D. products. Their trained pharmacists are ready to fill your prescriptions to the letter. For safety and economy get your prescriptions and drug store supplies at your convenient neighborhood Rexall Store.

UNITED DRUG COMPANY · BOSTON · ST. LOUIS · CHICAGO · ATLANTA
SAN FRANCISCO · LOS ANGELES · PORTLAND · PITTSBURGH · NOTTINGHAM · TORONTO
Pharmaceutical Chemists — Makers of tested-quality products for more than 39 years

Compare

BARD-PARKER FORMALDEHYDE GERMICIDE
with any solution commonly used for the disinfection of surgical instruments...

1 AN EFFICIENT GERMICIDE

VEGETATIVE Test interval (minutes) producing sterility					SPORE Test interval (hours) producing sterility				
Test organism	PUS		BLOOD		Test organism	PUS		BLOOD	
	wet	dry	wet	dry		wet	dry	wet	dry
Staph. aureus	½	½	½	2	B. anthrasis	¼	¼	1	1
Strept. hemolyticus	½	½	½	*	Cl. tetani	18	18	18	18
Pseudomonas pyocyanea	½	½	½	1	Cl. welchii	1	2	4	4

*Controls negative—did not resist drying

2 CONSERVES THE BUDGETED DOLLAR

When used as directed, the Solution will not rust, corrode or otherwise damage steel instruments, glass or heat-treated rubber.

The Solution is non-injurious to the keen cutting edges of surgical knives and scissors, and delicate surgical instruments . . . thus serving to safeguard the surgeon's and hospital's instrument investment.

The Solution retains its high germicidal effectiveness over long periods of use if kept undiluted and free of foreign matter.

Ask your dealer

PARKER, WHITE & HEYL, INC.
DANBURY, CONNECTICUT

A BARD-PARKER PRODUCT

Harmony

IN THE KEY OF B_1

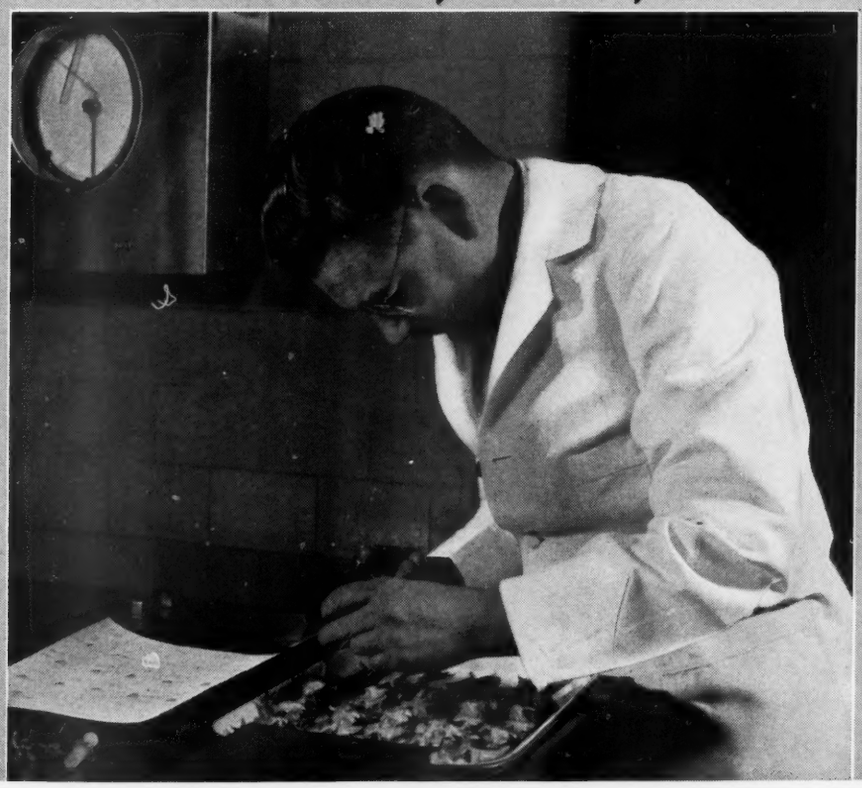
♪ Tune up your prescription with "Lixa-Beta - q. s." When you want to combine vitamin B_1 therapy with specific medication, Lixa-Beta will prove a delightfully palatable vehicle that contains 1600 U. S. P. Units of vitamin B_1 to the fluidounce. It provides a "common carrier" for most drugs, both soluble and insoluble as well as aqueous and oily substances. Why not give it a trial in your next prescription?

If you would like to obtain a complimentary supply and a list of drugs compatible with Lixa-Beta, please write a request on your letterhead to the Department of Professional Service.

Lixa - Beta is supplied in 8 ounce, pint and gallon bottles.

William R. Warner & Co., Inc., 113 W. 18th Street, New York City

The art of doing things well



IN THE Lilly Laboratories not just any cat or frog that happens along is used in standardizing digitalis. Lilly accuracy demands careful selection and housing of test animals under standard conditions in order to avoid individual variations due to environment and nutrition. Frogs which are being prepared for digitalis testing are held in a constant temperature bath where a variation of no more than 0.1° C. is permitted. The results of testing are evaluated by competent workers, some with over twenty years of experience in digitalis standardization.

Eli Lilly and Company

PRINCIPAL OFFICES AND LABORATORIES, INDIANAPOLIS, INDIANA, U. S. A.

Society Meetings

AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

Atlantic City, January 11–15, 1942. (Secretary—DR. REX L. DIVELEY, 1400 Professional Bldg., Kansas City, Mo.)

AMERICAN ASSOCIATION FOR THE STUDY OF GOITER

Atlanta, June 1–3, 1942. (Secretary—DR. T. C. DAVISON, 478 Peachtree St., N.E., Atlanta, Ga.)

AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA

Boston & Osterville, Mass., June 3–5, 1942. (Secretary—DR. GORDON M. MORRISON, 520 Commonwealth Ave., Boston)

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

Hershey, Pa., May 27–29, 1942. (Secretary—DR. CHARLES C. HIGGINS, 2020 East 93rd Street, Cleveland)

AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS

Cincinnati, April 13–17, 1942. (Secretary—MR. ARMOUR G. PARK, 540 N. Michigan Ave., Chicago)

AMERICAN ASSOCIATION OF OBSTETRICIANS, GYNECOLOGISTS AND ABDOMINAL SURGEONS

White Sulphur Springs, W. Va., September 10–12, 1942. (Secretary—DR. JAMES R. BLOSS, 418—11th St., Huntington, W. Va.)

AMERICAN ASSOCIATION OF RAILWAY SURGEONS

Chicago, September 10–12, 1942. (Secretary—DR. R. B. KEPNER, 547 W. Jackson Blvd., Chicago)

AMERICAN COLLEGE OF SURGEONS

Chicago, October 19–23, 1942. (Secretary—DR. FREDERIC A. BESLEY, 215 N. Sheridan Rd., Waukegan, Ill.)

AMERICAN CONGRESS OF PHYSICAL THERAPY

Pittsburgh, September 9–12, 1942. (Secretary—DR. RICHARD KOVACS, 2 East 88th Street, New York)

AMERICAN GYNECOLOGICAL SOCIETY

Skytop, Pa., June 15–17, 1942. (Secretary—DR. HOWARD C. TAYLOR, JR., 842 Park Avenue, New York)

AMERICAN MEDICAL ASSOCIATION

Atlantic City, June 8–12, 1942. (Secretary—DR. OLIN WEST, 535 N. Dearborn Street, Chicago)

AMERICAN ORTHOPAEDIC ASSOCIATION

Baltimore, June 3–5, 1942. (Secretary—DR. Charles W. PEABODY, 474 Fisher Bldg., Detroit)

AMERICAN PROCTOLOGIC SOCIETY

Atlantic City, June 7–9, 1942. (Secretary—DR. W. H. DANIEL, 1930 Wilshire Blvd., Los Angeles)

THE AMERICAN SOCIETY OF ANESTHETISTS, INC.

New York, April 9, 1942. (Secretary—DR. PAUL M. WOOD, 745 Fifth Avenue, New York)

AMERICAN SURGICAL ASSOCIATION

New Orleans, April 6–8, 1942. (Secretary—DR. CHARLES G. MIXTER, 319 Longwood Avenue, Boston)

ASSOCIATION OF MILITARY SURGEONS OF THE U. S.

San Antonio, November 5–7, 1942. (Secretary—COL. JAMES M. PHALEN, 1870 Wyoming Ave., N.W., Washington, D. C.)

CONGRESS OF ANESTHETISTS

(Secretary—DR. E. KLAUS, 1699 W. 25th Street, Cleveland)

INTERNATIONAL COLLEGE OF SURGEONS

Denver, July 15–18, 1942. (Secretary—DR. CHARLES H. ARNOLD, 903–15 Terminal Bldg., Lincoln, Nebr.)

INTER-STATE POST-GRADUATE MEDICAL ASSOCIATION OF NORTH AMERICA

Chicago, October 26–30, 1942. (Secretary—DR. TOM B. THROCKMORTON, 406 Sixth Avenue, Des Moines)

NEW ENGLAND SURGICAL SOCIETY

Worcester, Mass., 1942. (Secretary—DR. JOHN F. GILE, Hanover, New Hampshire)

PACIFIC COAST SOCIETY OF OBSTETRICS AND GYNECOLOGY

California, November, 1942. (Secretary—DR. W. B. THOMPSON, 6253 Hollywood Blvd., Los Angeles)

PACIFIC COAST SURGICAL ASSOCIATION

San Francisco and Del Monte, February 17–20, 1942. (Secretary—DR. FREDERICK L. REICHERT, Stanford University Hospital, San Francisco)

PAN-PACIFIC SURGICAL ASSOCIATION

Honolulu, 1942. (Secretary—DR. FORREST J. PINKERTON, Young Bldg., Honolulu)

SOUTHEASTERN SURGICAL CONGRESS

Atlanta, March 9–11, 1942. (Secretary—DR. B. T. BEASLEY, 701 Hurt Bldg., Atlanta)

SOUTHERN SURGICAL ASSOCIATION

Savannah, Ga., December 8–10, 1942. (Secretary—DR. ALTON OCHSNER, 1430 Tulane Avenue, New Orleans)

WESTERN SURGICAL ASSOCIATION

Memphis, December 4–5, 1942. (Secretary—DR. ARTHUR METZ, 2449 Washington Blvd., Chicago)

COOK COUNTY
GRADUATE SCHOOL OF MEDICINE

(In affiliation with COOK COUNTY HOSPITAL)

Incorporated not for profit

Announces continuous courses

SURGERY—Two Weeks Intensive Course in Surgical Technique with practice on living tissue, every two weeks throughout the year. General Courses One, Two, Three and Six Months; Clinical Courses; Special Courses. Rectal Surgery every week.

GYNECOLOGY—Two Weeks Intensive Course will be offered starting April 6th. Clinical and Diagnostic Courses every week.

OBSTETRICS—Two Weeks Intensive Course will be offered starting April 20th. Informal Course every week.

FRACTURES & TRAUMATIC SURGERY—Two Weeks Intensive Course will be offered starting May 4th. Informal Course available very week.

MEDICINE—Two Weeks Intensive Course will be offered starting June 1st. Two Weeks Course in Gastro-Enterology will be offered starting June 15th. One Month Course in Electrocardiography and Heart Disease every month, except December and August.

OTOLARYNGOLOGY—Two Weeks Intensive Course will be offered starting April 6th. Clinical and Special Courses starting every week.

OPHTHALMOLOGY—Two Weeks Intensive Course will be offered starting April 20th. Five Weeks Course in Refraction Methods starting May 11th. Informal Course every week.

ROENTGENOLOGY—Courses in X-ray Interpretation, Fluoroscopy, Deep X-ray Therapy every week.

GENERAL, INTENSIVE AND SPECIAL COURSES IN ALL BRANCHES OF MEDICINE, SURGERY AND THE SPECIALTIES

Teaching Faculty—Attending Staff of

COOK COUNTY HOSPITAL

Address: Registrar, **427 South Honore Street, Chicago, Illinois**

THE NEW YORK POLYCLINIC
MEDICAL SCHOOL AND HOSPITAL

(ORGANIZED 1881)

(The Pioneer Post-Graduate Medical Institution in America.)

UROLOGY

A combined full time course covering an academic year (8 months). It comprises instruction in pharmacology; physiology; embryology; biochemistry; bacteriology and pathology; practical work in surgical anatomy and urological operative procedures on the cadaver; regional and general anesthesia (cadaver); office gynecology; proctological diagnosis; the use of the ophthalmoscope; physical diagnosis; roentgenological interpretation; electrocardiographic interpretation; dermatology and syphilology; neurology; physical therapy; continuous instruction in cystoendoscopic diagnosis and operative instrumental manipulation; operative surgical clinics; demonstrations in the operative instrumental management of bladder tumors and other vesical lesions as well as endoscopic prostatic resection.

FOR THE

GENERAL PRACTITIONER

Intensive full time instruction in those subjects which are of particular interest to the physician in general practice. The course covers all branches of Medicine and Surgery.

FOR INFORMATION ADDRESS

MEDICAL EXECUTIVE OFFICER, 345 West 50th Street, NEW YORK CITY

ALWAYS COMFORTABLE!

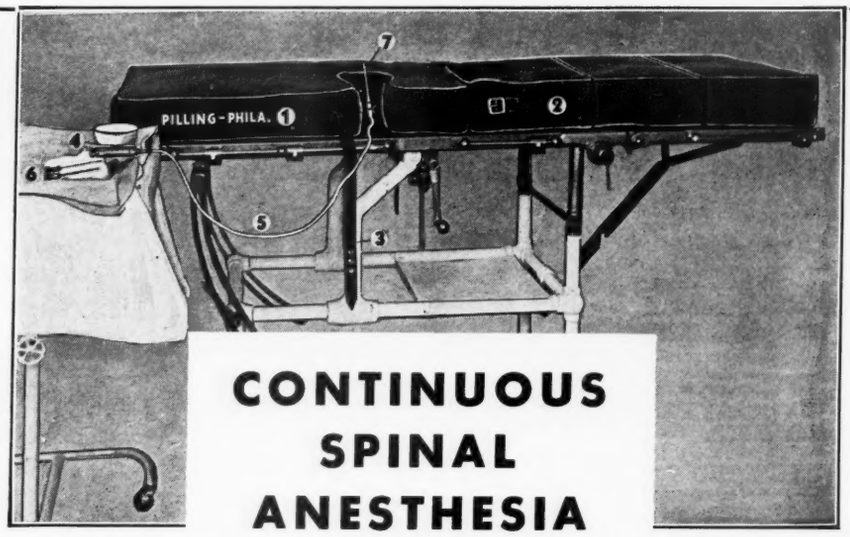
Elastoplast
REG. U. S. PAT. OFF.

The Dependable E-L-A-S-T-I-C
Adhesive Bandage

Elastoplast provides perfect support and compression. It is pliable . . . does not restrict movement.

DUKE
LABORATORIES, INC.
STAMFORD, CONN., U. S. A.

Elastoplast is available at your dealer in 2 styles: Elastoplast Type "A," entirely coated — permits bathing. Type "C"—half coated with adhesive—for use on hypersensitive skin. Write for sample of Elastoplast and Nivea Skin Oil, the surgeons' hand lotion.



CONTINUOUS SPINAL ANESTHESIA

DESCRIBED IN THIS ISSUE PAGE 504

Designed by Wm. T. Lemmon, M.D. Jefferson Hospital, Philadelphia, used in a large variety of over 1100 operations. Can be used on any operating table. Interesting reprint describing the technique and equipment sent on request.

MADE AND SOLD BY
THE GEORGE P. PILLING & SON COMPANY
Arch & Twenty-third Sts. Philadelphia, Pa., U. S. A.

HASLAM

EST. 1848

Haslam

AMERICA'S

FOREMOST

MAKERS OF

SURGICAL INSTRUMENTS

FRED HASLAM & CO., INC. 83 Pulaski St., Brooklyn, N. Y.

Try This Nylon Surgical Suture

BRAIDED from strands of du Pont Nylon . . . an inert, synthetic material, having abundant tensile strength and elasticity and unusual smoothness and uniformity.

Laboratory Tests and animal experiments show the action of nylon in the tissues is similar to that of natural silk. Its fibers are stable and are not dissolved by digestive or tissue enzymes. DEKNATEL SURGICAL NYLON is given a special moisture and serum proof treatment.

Samples sent on request.

Made in U. S. A.

Deknatel Surgical Nylon

Braided and Treated

DEKNATEL -- Queens Village, L. I. New York

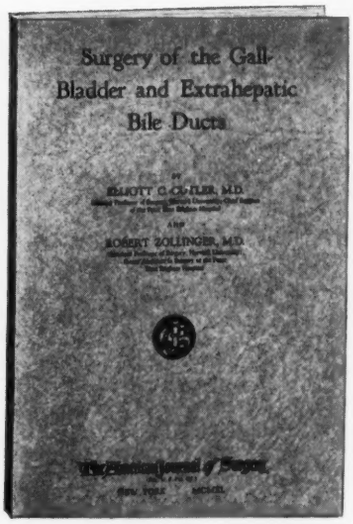
Makers of: DEKNATEL SURGICAL NYLON

DEKNATEL EYELESS NEEDLE DEKNATEL SURGICAL SILK

BOUND MONOGRAPHS

FROM THE 1940-41 ISSUES

The American Journal of Surgery



Surgery of the Gall-Bladder and Extrahepatic Bile Ducts—by Elliott C. Cutler and Robert Zollinger. 76 pages

The Estimation of Pelvic Capacity—By Herbert Thoms. 46 pages

Placenta Previa—By Julius Jarcho. 38 pages

The Diagnosis and Treatment of Hyperthyroidism and Associated Conditions—By Arthur Goetsch. 64 pages

The Surgery of Mediastinal Tumors—By George J. Heuer and William Andrus. 80 pages

Diagnosis and Treatment of Various Types of Diaphragmatic Hernia—By Stuart W. Harrington. 66 pages

Surgical Aids to the Intracavitary Treatment and Study of Cancer of the Stomach—By Edward M. Livingston and George T. Pack. 98 pages

Cancer of the Tonsil—By Hayes Martin and Everett L. Sugarbaker. 40 pages

Urology in the Female—By Houston S. Everett. 136 pages

Compression of Cancellous Bone—By Eugene J. Bozsan. 78 pages

Cesarean Section—By Charles A. Gordon and Alexander H. Rosenthal. 60 pages

Cancer of the Gums (Gingivae)—By Hayes Martin. 40 pages

Just 250 Numbered, Paper Bound, Copies of Each Printed

$1.00 per copy

The American Journal of Surgery, Inc.

49 WEST 45TH STREET · NEW YORK, N. Y.

HYDROSULPHOSOL
for BURN INJURIES

"There has been no clinical evidence of infection in any of the cases studied, nor has there been any evidence of toxicity. The solution is sufficiently bland that in diluted form it can be employed to advantage in burns of the eye.

"In the cases so far studied, this solution appears to fulfill the several requisites of a successful local treatment of burns more completely than any other single treatment with which we have been familiar. There is incomplete evidence that certain components of the solution tend to counteract shock."*

*"*A New Sulfhydryl Solution for the Treatment of Burns*" INDUSTRIAL MEDICINE Vol. II, No. 1, Jan. 1942.

Write for Reprints

E. C. Lientz and Co., Inc. ★ ★ ★ ★

1006 WEST SIXTH STREET, LOS ANGELES, CALIF.

REPRESENTING COTTIE-WILSON LABORATORIES

Every Doctor Should Read This Outstanding Number!

THE APRIL 1942

SYMPOSIUM

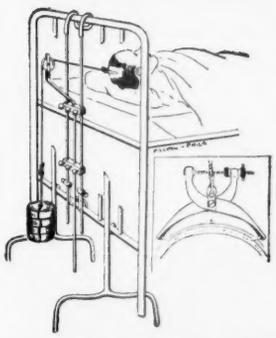
DIAGNOSIS IN SURGICAL CONDITIONS

Guest Editor, James T. Priestley, Mayo Clinic

300 Pages 100 Illustations

THE LEADING INDEPENDENT SURGICAL JOURNAL

PILLING INSTRUMENTS



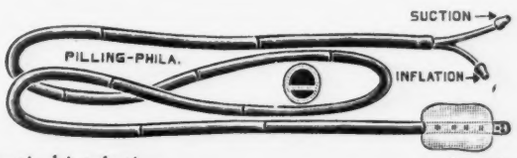
CRUTCHFIELD SKULL TONGS

W. Gayle Crutchfield, M.D., Dept. of Neurological Surgery, Medical College of Virginia, Richmond, Virginia.

P16605 Crutchfield Tong Set for fracture dislocations of the cervical spine; complete set of tongs (rustless steel), geared drill and two drill points..... **$30.00**

Reprint and technique on request.

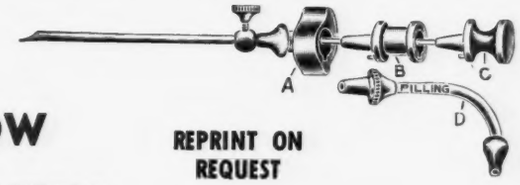
MILLER-ABBOTT DOUBLE LUMEN TUBE



P9140 Miller-Abbott double lumen tube for small intestinal intubation..... **$7.50**

Descriptive 12-page pamphlet with technique and bibliography sent on request.

TOCANTINS SET FOR INFUSION VIA THE BONE MARROW



REPRINT ON REQUEST

MADE AND SOLD BY

THE GEORGE P. **PILLING** & SON COMPANY

Arch & Twenty-third Sts. Philadelphia, Pa., U. S. A.

USE LAVORIS

As a Mouthwash

In the sick room

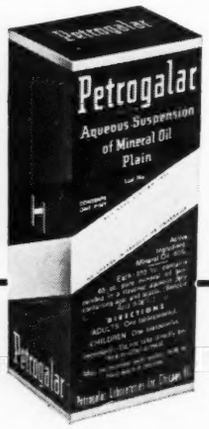
It coagulates and clears away offensive matter

Come and get it!

• Look at him go! First in any chow line, this rookie's enthusiastic gorging is offset, fortunately, by a strenuous program of exercise. His counterpart among the "Rocking Chair Brigade" still has to be considered. When over-indulgence and lack of exercise are causative factors in constipation, relief may often be obtained with Petrogalar.*

It helps to soften thoroughly the stool and encourages regular, comfortable bowel movement. Petrogalar is acceptable even with "stuffy" patients because of its pleasant taste and ready miscibility in water.

It may be taken directly from the spoon or from a glass. Consider Petrogalar for the treatment of constipation.



FOR THE TREATMENT OF CONSTIPATION

—Petrogalar—

*Reg. U. S. Pat. Off. Petrogalar is an aqueous suspension of pure mineral oil each 100 cc. of which contains 65 cc. pure mineral oil suspended in an aqueous jelly containing agar and acacia.

Petrogalar Laboratories, Inc. • 8134 McCormick Boulevard • Chicago, Illinois

Nutritional Problems

AND SURGICAL MANAGEMENT

Rapid nutritional replenishment is an important phase of surgical recovery. Yet many postoperative patients cannot consume sufficient food to provide the organism with required nutrients.

New Improved Ovaltine is an effective means of bolstering depleted carbohydrate, protein, mineral, and vitamin stores. Attractive to the palate, this delicious food drink can be taken almost as soon as liquids are tolerated. Its easy digestibility, its low curd tension, and the absence of residue make it an especially valuable concentrated food after any type of surgery.

Three daily servings (1½ oz.) of New Improved Ovaltine provide:

	Dry Ovaltine	Ovaltine with milk*
PROTEIN	6.00 Gm.	31.20 Gm.
CARBOHYDRATE	30.00 Gm.	66.00 Gm.
FAT	3.15 Gm.	31.95 Gm.
CALCIUM	0.25 Gm.	1.05 Gm.
PHOSPHORUS	0.25 Gm.	0.903 Gm.
IRON	10.5 mg.	11.9 mg.
COPPER	0.5 mg.	0.5 mg.
VITAMIN A	1500 U.S.P.U.	2953 U.S.P.U.
VITAMIN D	405 U.S.P.U.	432 U.S.P.U.
VITAMIN B_1	170 U.S.P.U.	302 U.S.P.U.
RIBOFLAVIN	0.25 mg.	1.28 mg.

*Each serving made with 8 oz. milk; based on average reported values for milk.

NEW IMPROVED *Ovaltine*

2 KINDS—PLAIN AND CHOCOLATE FLAVORED

Ovaltine now comes in 2 forms—plain, and sweet chocolate flavored. Serving for serving, they are virtually identical in nutritional value.

• • •

Physicians are invited to send for a supply of individual servings of New Improved Ovaltine. The Wander Company, 360 N. Michigan Ave., Chicago, Ill.

Suiting the *spinal anesthetic* to the case

When a time-consuming operation has to be performed, a relatively long lasting anesthetic agent is indicated. Pontocaine hydrochloride induces spinal anesthesia which lasts for two hours or more and is employed extensively for surgical procedures of prolonged duration. When spinal anesthesia lasting for only about an hour is required, Novocain is customarily injected.

Thus, the surgeon or anesthetist can choose the drug best suited to the individual case.

PONTOCAINE

Reg. U. S. Pat. Off. & Canada

Brand of TETRACAINE

Para-butyl-aminobenzoyl-dimethyl-amino-ethanol

HYDROCHLORIDE

How Supplied: "Niphanoid" in ampules of 10 mg. and 20 mg., boxes of 10 and 100; 1 per cent solution (10 mg. per 1 cc.) in ampules of 2 cc., boxes of 10 and 50.

NOVOCAIN

Reg. U. S. Pat. Off. & Canada

Brand of PROCAINE HYDROCHLORIDE

How Supplied: Novocain Crystals in ampules containing 50, 100, 120, 150, 200 or 300 mg., boxes of 10 and 100; Novocain Solution 10 per cent in ampules of 2 cc. (200 mg.), boxes of 10 and 100.

WINTHROP

WINTHROP CHEMICAL COMPANY, INC.

Pharmaceuticals of merit for the physician

NEW YORK, N. Y. WINDSOR, ONT.

ACCEPTED AMERICAN MEDICAL ASSN

SHOCK ABSORBER

Theelin acts as a therapeutic cushion to help absorb the physical and mental shocks so often caused by ovarian hypofunction during the menopause. Theelin accomplishes this by replacing or supplementing declining ovarian secretion until such time as the endocrine system can adjust itself to the hormonal deficiency. Its clinical reputation is firmly established on the basis of millions of doses successfully used. Indications: the climacteric, senile vaginitis, kraurosis vulvae, gonorrheal vaginitis in children, and certain other conditions due to estrogenic insufficiency. Theelin was the first estrogen to be isolated in pure crystalline form. Each lot is physiologically and chemically standardized before release by the laboratories of Parke, Davis & Company and by the Biochemical Laboratory of St. Louis University. Theelin Suppositories for vaginal use and Kapseals Theelol for oral administration are available where sustained therapy between injections is desired.

*Reg. U. S. Pat. Off.

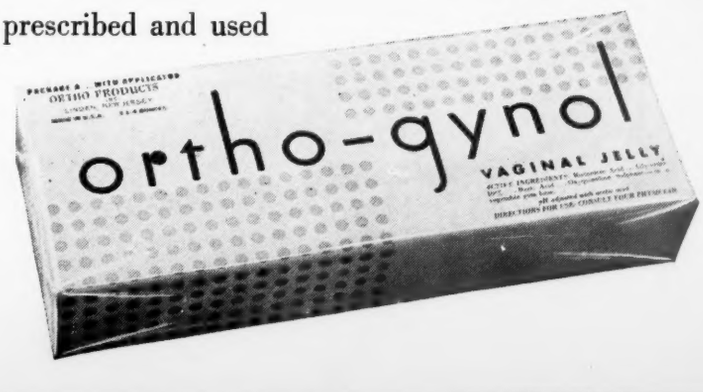
Ampoules **THEELIN*** and Kapseals **Theelol***

products of modern research offered to the medical profession by

PARKE, DAVIS & COMPANY DETROIT, MICHIGAN

OVER SEVENTY-FIVE YEARS OF SERVICE TO MEDICINE AND PHARMACY

March Winds... herald the transition from the cold of winter to the warmth of springtime... Climate and weather are important considerations in the preparation of vaginal jellies. They must be stable under all normal conditions of temperature, moisture and other variables. Ortho-Gynol is prescribed and used in the cold of Alaska as well as in the jungle heat of equatorial South America. When you prescribe it you may be sure your patient can always obtain it in good condition anywhere.



COPYRIGHT 1942, ORTHO PRODUCTS, INC., LINDEN, N. J.

The American Journal of Surgery

ADVERTISERS INDEX

Instruments and Apparatus

Austenal Laboratories, Inc.	*February*
Bard-Parker Co., Inc.	19
Crescent Surgical Sales Co., Inc.	*January*
General Electric X-ray Corp.	9
Fred Haslam & Co., Inc.	25
Parker, White & Heyl, Inc.	19
Picker X-ray Corp.	*February*
Geo. P. Pilling & Son Co.	24, 29
J. Sklar Manufacturing Co.	10
Edward Weck & Co., Inc.	13

Sutures

Davis & Geck, Inc.	*Insert facing 2nd Cover*
J. A. Deknatel & Son, Inc.	25
Johnson & Johnson	*Insert facing Editorial*

Pharmaceuticals

Abbott Laboratories	6
Alba Pharmaceutical Co., Inc.	15
American Hospital Supply Corp.	*February*
Arlington Chemical Co.	*February*
The Armour Laboratories	*December*
Baxter Laboratories, Inc.	*February*
Ernst Bischoff Co., Inc.	1
Chatham Pharmaceuticals, Inc.	*February*
Ciba Pharmaceutical Products, Inc.	*4th Cover*
Cutter Laboratories	17
Hoffmann-La Roche, Inc.	2
Hynson, Westcott & Dunning, Inc.	*January*
The Lavoris Company	29
Lederle Laboratories, Inc.	14
Thos. Leeming & Co., Inc.	*February*
E. C. Lientz & Co., Inc.	27
Eli Lilly and Company	21
Merck & Co., Inc.	12
National Drug Co.	8
Ortho Products, Inc.	34
Parke, Davis & Co.	33
Petrogalar Laboratories, Inc.	30
Schering & Glatz, Inc.	*February*
G. D. Searle & Co.	11
E. R. Squibb & Sons	16
Frederick Stearns & Co.	*February*
United Drug Co.	18
The Upjohn Co.	*February*
Wallace & Tiernan Products, Inc.	7
Wm. R. Warner & Co., Inc.	20
Winthrop Chemical Co., Inc.	32
John Wyeth & Bro., Inc.	*February*

Hospital Supplies

American Hospital Supply Corp.	*February*
Baxter Laboratories, Inc.	*February*
Becton, Dickinson & Co.	*February*
Crescent Surgical Sales Co., Inc.	*January*
Cutter Laboratories	17
Duke Laboratories, Inc.	24
General Electric X-ray Corp.	9
Fred Haslam & Co., Inc.	25
Johnson & Johnson	*February*
Macalaster Bicknell Co.	*December*
Massillon Rubber Co.	27
Picker X-ray Corp.	*February*
J. Sklar Manufacturing Co.	10

Post-Graduate Instruction

Cook County Grad. Sch. of Med.	23
N. Y. Polyclinic Med. School	23

Foods

The Wander Company	31

Medical Books

The American Journal of Surgery	26, 28
Little, Brown & Co.	5

PICTURE OF A PATIENT WITH *Pharyngitis*

When your patients with pharyngitis, tonsillitis or aphthae complain of feeling as if they had swallowed a sword, NUPORALS, "Ciba," offer quick relief. Containing the well-known anesthetic, Nupercaine* (α — butyloxychinchoninic acid diethylethylenediamide hydrochloride), these lozenges produce a prolonged local anesthesia of the mucous membranes of the oral cavity and throat when dissolved in the mouth.

Further suggested uses for NUPORALS* include facilitating pharyngeal and laryngeal examinations, easing the passage of a stomach tube, curtailing pain induced by denture irritation or surgical trauma.

BOXES OF 15 **NUPORALS** BOTTLES OF 100

*Trade Mark Reg. U. S. Pat. Off. The word "Nuporals" identifies throat lozenges of Ciba's manufacture, each lozenge contains one mgm. of Nupercaine, "Ciba."

C·I·B·A

CIBA PHARMACEUTICAL PRODUCTS, INC., SUMMIT, NEW JERSEY